GEOTECHNICAL DATA REPORT

P984-P989 Marine Corps Security Force Regiment Consolidation, Phase I NWS Yorktown, Virginia

A/E Contract N62470-12-D-2003, WE09
GER Project No. 110-5960

prepared for
NAVFAC Mid-Atlantic
Norfolk, Virginia

July 18, 2012

GER GeoEnvironmental Resources, Inc.
Consulting Engineers
Environmental • Groundwater • Hazardous Materials • Geotechnical • Industrial Hygiene

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July 18, 2012

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Norfolk, Virginia 23511

Attention: **Ms. Michelle Perry**
Code OPHRC17

Subject: **Geotechnical Data Report**
P984-P989 Marine Corps Security Force Regiment Consolidation, Phase I
Naval Weapons Station, Yorktown, Virginia
A/E Contract No. N62470-12-D-2003, WE09
GER Project No. 110-5960

GeoEnvironmental Resources, Inc. is pleased to present this geotechnical data report conducted for the above referenced project for NAVFAC Mid-Atlantic under A/E Contract No. N62470-12-D-2003, Task Order WE09.

We appreciate the opportunity to serve as your geotechnical consultant on this project and trust that you will contact us at your convenience with any questions concerning this report or the project in general.

Sincerely,
GeoEnvironmental Resources, Inc.

Crystal L. Cox, P.E.
Project Engineer

COMMONWEALTH OF VIRGINIA
7/18/12
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PROFESSIONAL ENGINEER

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EXECUTIVE SUMMARY

The subsurface conditions at the project site were explored by 32 standard penetration test (SPT) soil borings conducted to depths ranging from 20 to 40 feet below existing grades, 4 dilatometer test (DMT) soundings conducted to depths of 40 feet below existing grades, and two seismic cone penetration test (SCPTU) soundings pushed to a depth of 100 feet below existing grade. Down-hole shear wave velocity measurements were obtained in the SCPTU soundings. Three temporary piezometers were installed in 3 SPT boring locations for 24-hour and 48-hour groundwater observations. Six field saturated hydraulic conductivity tests were conducted at selected boring locations. Laboratory classification and CBR testing was conducted on representative soil samples collected from the borings.

The subsurface conditions encountered in the upper 45 feet of the soil borings and in-situ test soundings were interpreted as five general stratigraphic layers of natural Coastal Plain sediments. They included:

- Stratum 1 - very loose to firm silty and clayey SAND and soft to very stiff low and high plasticity silty and sandy CLAY and low plasticity clayey SILT to depths from about 2 to 7 feet.
- Stratum 2 - interlayered firm to dense silty and clayey SAND and stiff to hard low and high plasticity silty and sandy CLAY and low plasticity clayey SILT to depths from about 6 to 20 feet.
- Stratum 3 - interlayered very loose to firm slightly silty, silty and clayey SAND and soft to stiff low and high plasticity silty and sandy CLAY and low and high plasticity clayey SILT to depths from about 12 to 37 feet.
- Stratum 4 - very soft to soft low and high plasticity silty and sandy CLAY and low plasticity clayey SILT to depths from about 17 to 40 feet.
- Stratum 5 - very loose to firm silty SAND and SHELL and soft to firm low and high plasticity silty CLAY with trace shell fragments (Yorktown Formation) to maximum depths of the soil borings and DMT soundings.

The static groundwater table encountered in the test borings and in-situ test soundings showed significant variation across the site and were measured at depths ranging from about 4 to 30 feet below the ground surface during the exploration.

An approximate 2 to 8-inch layer of topsoil like material was encountered at the majority of the testing locations during the exploration. Asphalt thickness measured approximately 6 to 8 inches in thickness when encountered.

Laboratory CBR test values ranged from 1.4 to 4.9 on seven well compacted test samples obtained from the upper 2 feet.

Shear wave velocity measurements taken in the upper 100 feet of the site profile ranged from about 550 to 2600 feet per second and averaged about 1200 feet per second.

Six field saturated hydraulic conductivity tests conducted at depths ranging from about 2.5 to 4.5 feet in the Stratum 1 sand and clay soils indicated rates ranging from about 0 to 3.5 inches per hour.

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Purpose of Study

The purpose of this study was to collect geotechnical data from the proposed P-984, P-985, P-986, P-987 and P-989 projects as part of the Marine Corps Security Force Regiment Consolidation, Phase I at the proposed project site and to prepare this report of the findings in support of a NAVFAC Mid-Atlantic in-house design or as part of a future design-build solicitation.

Project Information

The project is located at three distinct sites located at Naval Weapons Station (NWS) Yorktown, Virginia. The individual sites are located along Shupper Drive, Longfellow Road and Halstead Road at NWS Yorktown. A site vicinity plan is shown in Drawing 1 in Appendix A. A site location plan is shown in Figure 1 and on Drawing 2 in Appendix A.

We understand the projects will construct a Regimental Headquarters Building, a Bachelor Enlisted Quarters (BEQ), a Motor T Facility, a Supply Warehouse and an Armory. Supporting parking facilities and pavements are planned in conjunction with the Regimental Headquarters, Motor T Facility, Supply Warehouse and Armory. An additional parking area will be provided along Shupper Drive. A geothermal investigation was conducted to support the BEQ. Stormwater management facilities are anticipated for each of the buildings and/or projects. Structural and site grading information associated with the proposed project are unknown at this time.

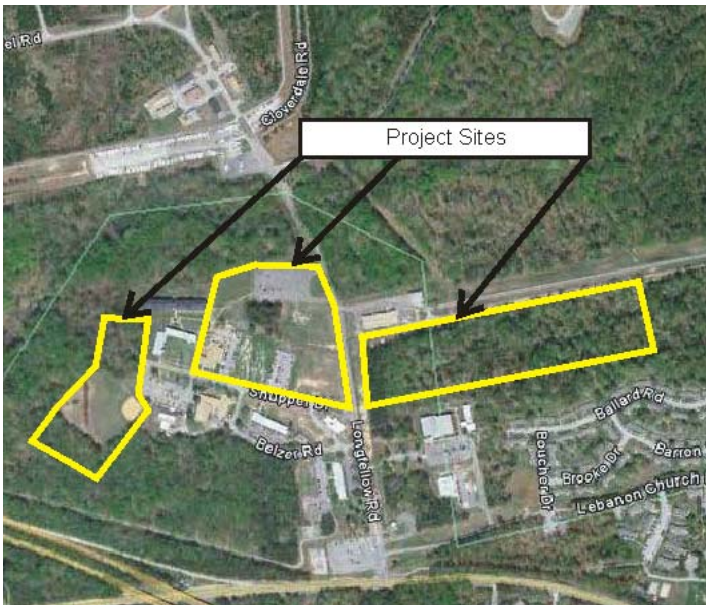


Figure 1. *Site Location*

Site Description

The project sites are located within the existing Marine Corps training grounds located off of Shupper Drive and Longfellow Road and also within the existing wooded region adjacent to Halstead Road, the majority of which is currently situated off-post. Areas located within the existing Marine Corps training ground consist of the existing asphalt paved parking lot adjacent Gray Hall, the grassed landscape area currently located adjacent Gray Hall, the grass covered grounds and football field located adjacent Shupper Drive and the Second Fleet Antiterrorism Security Team Building and also the wooded undeveloped area, training ground and baseball field currently located at the end of Shupper Drive. The majority of the site adjacent to Halstead Road is densely treed with some areas of heavy brush and many fell trees across the site. An aggregate surfaced access road is present adjacent to Halstead Road at the portion of the site located on-post. Several underground utilities are present within the landscaped area adjacent to Gray Hall and also along the aggregate surfaced access road adjacent Halstead Road and along the easement located adjacent Longfellow Road. Ground surface elevations at the site range from approximately 50 to 80 feet based on provided topographic survey data.

Site Geology

The project site lies within Virginia's Atlantic Coastal Plain physiographic province. The Coastal Plain is characterized by an eastward thickening wedge of marine, estuarine and fluvial sediments that were deposited in a series of marine transgressive-regressive cycles, or high and low stands of sea level, during the Holocene to Miocene epochs of the late Cenozoic era.

According to the Virginia GIS Database of Geologic Units based on the 1993 Geologic Map of Virginia, the upper geologic units at the site are composed of Pleistocene age deposits of the Windsor Formation that include fluvial and estuarine silt, sand, clay and gravel. Older underlying units

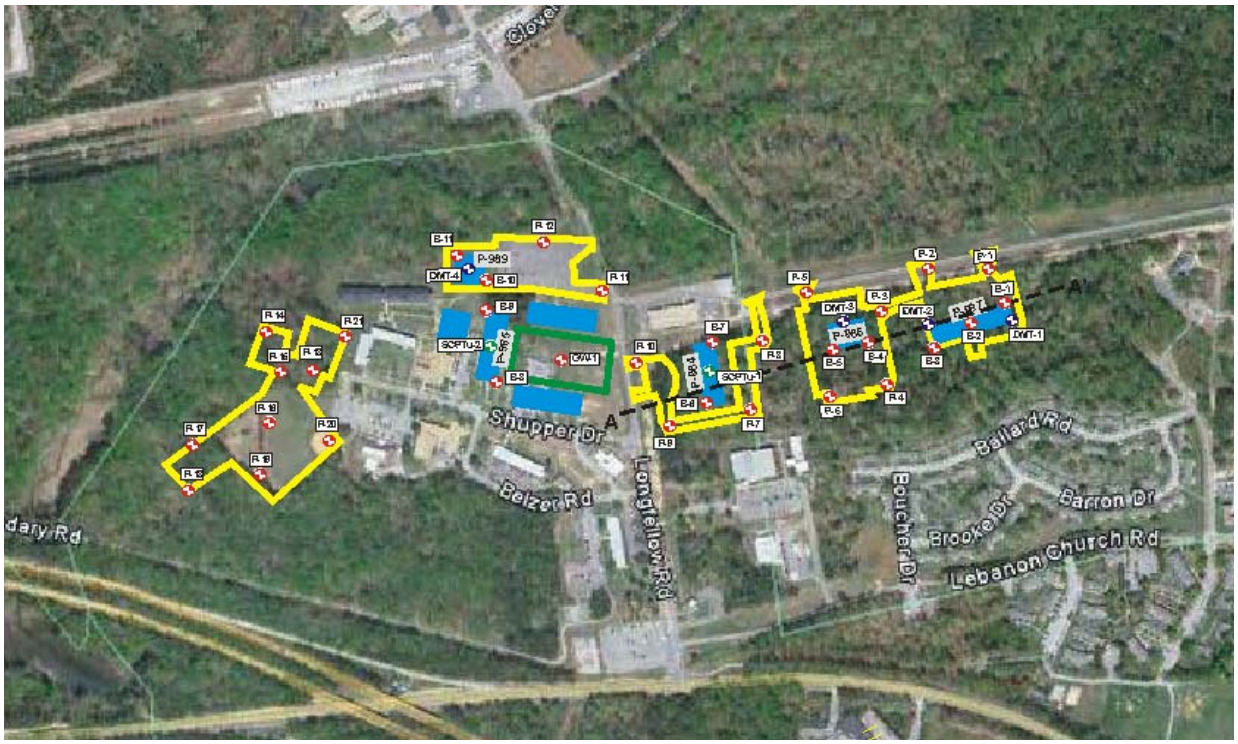


Figure 2. *Testing Location Plan*

include consolidated Tertiary deposits of the Yorktown and Eastover Formations, undivided, described as marine deposits consisting of fossiliferous sand and shelly sand deposits, sand and clay. Metamorphic and igneous basement bedrock is located at more than 1000 feet below sea level.

Exploration Program

The subsurface exploration program consisted of the following sampling and testing at the approximate locations shown in Figure 2 and on Drawing 3 in Appendix A:

- Performing 18 standard penetration test (SPT) soil borings to a depth of 20 feet below existing grades for the proposed pavement areas. The testing locations were designated using the notation P-X.
- Performing 3 SPT soil borings, designated P-4, P-6 and P-7 to a depth of 35 feet below existing grades for the proposed pavement areas.
- Performing 1 SPT soil boring, designated B-7, to a depth of 35 feet below existing grade at a proposed building location.
- Performing 9 SPT soil borings to a depth of 40 feet below existing grades for the proposed building locations. The testing locations were designated using the notation B-X.
- Performing 1 SPT soil boring, designated B-6, to a depth of 45 feet below existing grades at a proposed building location.
- Conducting 4 dilatometer test (DMT) soundings, designated DMT-1, DMT-2, DMT-3 and DMT-4, to a depth of 40 feet below existing grades at proposed building locations.
- Performing 2 seismic piezocone penetration test (SCPTu) soundings, designated SCPTu-1 and SCPTu-2 to a depth of approximately 100 feet below existing grades at proposed building locations. Down-hole shear wave velocity (Vs) measurements were obtained at nominal 5-foot depth intervals in the SCPTu sounding.
- Installing 3 temporary piezometers to depths of 20 feet at locations P-1, P-6 and P-15 for measuring stabilized groundwater levels at 24-hour and 48-hour periods.
- Conducting 6 constant head field saturated conductivity tests at locations P-1, P-6, P-8, P-9, P-15 and P-18 for measuring soil

permeability at depths ranging from about 2.5 to 4.5 feet below the existing ground surface.

- Collecting 7 bulk samples in the upper 2 feet at locations P-1, P-3, P-8, P-9, P-13, P-14 and P-18 for laboratory CBR tests.
- Performing geotechnical laboratory testing that included natural moisture content, grain size, Atterberg limits, moisture-density relationship and CBR on selected representative samples recovered from the soil borings.

Drawings showing site information and interpreted subsurface data are provided in Appendix A. Field exploration data are provided in Appendix B. Laboratory test results are provided in Appendix C. Exploration procedures and interpretation methods used in this study are provided in Appendix D.

The testing locations and depths were selected by NAVFAC Mid-Atlantic. Test locations were established in the field using the site plans provided to us and available reference landmarks. Horizontal position (WGS84 lat/lon) of the test locations was measured in the field using a handheld GPS receiver with an accuracy of 3 meters. The measured geographic positions of the test locations are shown on the exploration program summary in Appendix B. Ground surface elevations at the testing locations were not available or have not been provided to us at this time.

The test borings were conducted from June 18 through June 27, 2012. Borings were advanced by a CME 55 ATV mounted drill rig using nominal 3-inch diameter boreholes and mud rotary drilling techniques at borings with a depth of 35 feet or greater, and by 2¼ inch ID hollow stem auger drilling at boring locations with a depth of 20 feet. Standard penetration test (SPT) sampling was conducted in the borings at discreet intervals in general accordance with ASTM D 1586. An automatic hammer was used to drive the sampler. Small disturbed samples were obtained during the test and were used to classify the soil.

Measurements of water table depth were made in the open boreholes at completion of each boring. Temporary 2-inch diameter piezometers were installed within Borings P-1, P-6 and P-15. Slotted screen with a sand pack was set below the encountered groundwater table and the borehole annulus around each piezometer at the ground surface was sealed with bentonite. Measurements of water table depth were made at approximately 24 and 48 hours after boring completion in the piezometers and in the open boreholes at the other locations. The boreholes were backfilled with a cement-bentonite grout mix upon completion of these measurements.

Field saturated hydraulic conductivity tests were conducted at depths ranging from about 2.5 to 4.5 feet adjacent to locations P-1, P-6, P-8, P-9, P-15 and P-18 using a constant head well permeameter. The constant head method is based on Darcy's Law, Q=kiA. The test involves creating a ponded height of water in an open well or borehole to establish a bulb of field saturated soil around the base of the borehole. Once the saturated bulb becomes established, the flow of water out of the borehole and into the soil should approach a constant rate (steady state flow). To accomplish the tests, boreholes were augered to the requested testing depths. After the inserting the permeameter into the boreholes, measurements of flow and time were recorded until a relatively steady flow rate was observed or until it was obvious that a steady state flow would not be achieved. The field saturated hydraulic conductivity, K_{fsat}, was calculated according to the procedures of Reynolds et al. (1993) and the US Bureau of Reclamation (1990).

The dilatometer test (DMT) soundings were performed at locations DMT-1, DMT-2, DMT-3 and DMT-4 in general accordance with ASTM D6335. The DMT is an in-situ test device having a relatively thin blade (14 mm) and flat face (95 mm wide by 220 mm long). The blade is pushed into the soil to the desired testing depths. One side of the flat blade contains a 60-mm diameter circular membrane. The membrane is expanded to take pressure readings after the DMT has been pushed to the desired depths - one foot intervals for this study. The DMT, like the CPT, generally cannot be pushed through very dense, hard, or gravely soils that might damage the membrane or buckle the blade.

Dual gages provide measurements of the pressure required to expand the DMT membrane. The first measurement (A reading) is the pressure required to lift the membrane 0.1 mm off its seat so it is flush with the plane of the blade. The second measurement (B reading) is the pressure required to expand the membrane by an additional 1.0 mm

into the soil. These pressures are used to estimate the in-situ lateral stress and lateral soil stiffness. DMT results have been correlated with other soil properties and used as the basis for some engineering design methodologies.

The cone penetrometer test (CPT) soundings were conducted using an integrated electronic seismic piezocone with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80. The piezocone dimensions and the operating procedure were in accordance with ASTM D5778. Pore pressure filter elements made of porous plastic were saturated under a vacuum using silicone oil as the saturating fluid. The pore pressure element was 6 mm thick and was located immediately behind the tip (the U_2 location).

The cone was advanced using a 20-ton track mounted CPT rig. Tip resistance (qc), sleeve friction (fs) and dynamic pore pressure (u) data were recorded every five centimeters as the cone was advanced into the ground. The reported tip resistance (qt) was corrected for porewater effects.

Down-hole shear wave velocity (Vs) measurements in general accordance with ASTM D7400 were obtained at nominal 5-foot depth intervals during the sounding. Shear wave velocity is defined as the speed at which propagating elastic waves travel through media. Shear wave velocity data can be interpreted for relative indications of material structure, density and stiffness.

Exploration Results

The subsurface conditions encountered at the soil boring, DMT and CPT locations are shown on the test boring, DMT and CPT records in Appendix B. The test boring records represent our interpretation of the subsurface conditions based on visual examination of field samples obtained and laboratory classification testing on selected samples. The lines designating the interface between various strata on the test boring records represent the approximate interface location. In addition, the transition between strata may be more gradual than the records imply.

Note that the soil material types and strata depths shown on the testing records are not necessarily representative of all materials that will be encountered during construction. Water levels shown on the testing records only represent the conditions at the date of the measurements.

Soil Stratigraphy

The interpreted subsurface profile at the testing locations was composed of five general stratigraphic layers. Figure 3 and Drawing 4 in

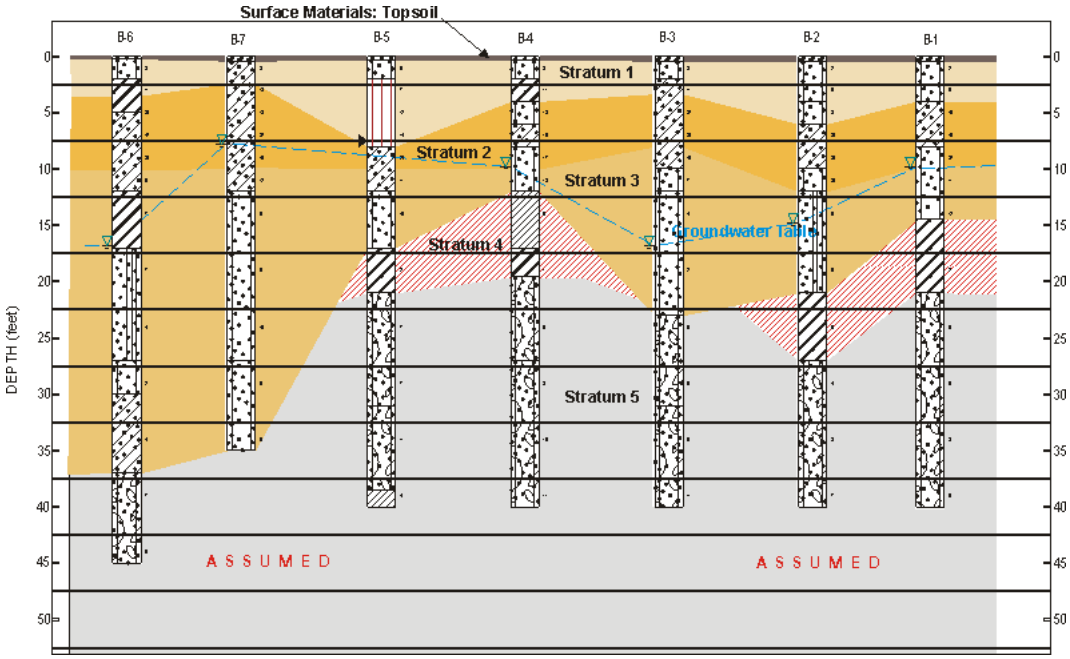


Figure 3. *Estimated Subsurface Profile, Halstead Road*

Appendix A show an estimated subsurface profile based on selected test boring results and locations, namely building locations along Halstead Road. Variations between the estimated profile and actual subsurface conditions can be expected.

STRATUM 1 was encountered beneath surface materials. It extended to depths ranging from about 2 to 7 feet below the ground surface depending on testing location. It is composed of interlayered very loose to firm silty and clayey SAND (SM, SC) and soft to very stiff low and high plasticity silty and sandy CLAY (CL, CH) and low plasticity clayey SILT (ML). SPT resistances ranged from 2 to 19 blows per foot (bpf) and averaged about 8 bpf in sands of Stratum 1 and ranged from about 4 to 16 bpf and averaged about 9 bpf in the clays and silts of Stratum 1.

STRATUM 2 is composed of interlayered firm to dense silty and clayey SAND (SM, SC) and stiff to hard low and high plasticity silty and sandy CLAY (CL, CH) and low plasticity clayey SILT (ML). It was encountered below Stratum 1 and extended to a depths ranging from about 6 to 20 feet below existing grade at the majority of the boring locations and and in-situ testing locations. This layer was not encountered at boring locations B-8, P-3 and P-11. SPT resistances ranged from 15 to 42 bpf and averaged about 20 bpf in sands of Stratum 2 and ranged from about 14 to 40 bpf and averaged about 22 bpf in the clays and silts of Stratum 2.

STRATUM 3 was encountered below Stratum 1 or Stratum 2 in all borings and in-situ test soundings. It extended to a depth ranging from about 12 to 37 feet below existing grade. Stratum 3 is composed of interlayered very loose to firm slightly silty, silty and clayey SAND (SP-SM, SM, SC) and soft to stiff low and high plasticity silty and sandy CLAY (CL, CH) and low and high plasticity clayey SILT (ML, MH). SPT resistances ranged from 3 to 18 bpf and averaged about 9 bpf in sands of Stratum 3 and ranged from about 4 to 12 bpf and averaged about 8 bpf in the clays and silts of Stratum 3. The majority of the shallow 20 foot borings terminated in this layer and one of the 35 foot borings, B-7, terminated in this layer.

STRATUM 4 was encountered below Stratum 3 in most of the remaining shallow 20 foot borings and in some of the deeper borings and in-situ soundings. It extended to a depth ranging from about 17 to 40 feet below existing grade when encountered. Stratum 4 is composed of very soft to soft low and high plasticity silty and sandy CLAY (CL, CH) and low plasticity clayey SILT (ML). SPT resistances ranged from 0 to 4 bpf and averaged 2 bpf in this layer. The majority of the remaining shallow borings and boring B-8 terminated in this layer.

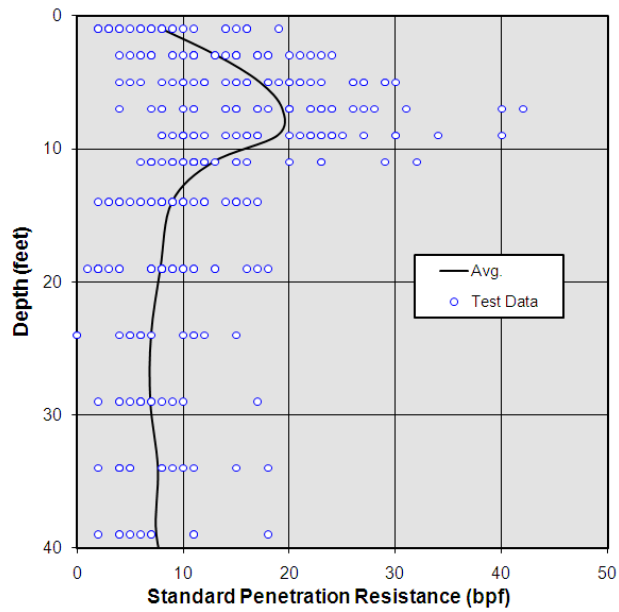


Figure 4. *SPT Resistance Profile*

STRATUM 5 was encountered below Stratum 4 in the remaining shallow and deeper borings and in all in-situ test soundings. It extended to the 40 and 45-foot termination depths of the borings and DMT soundings. Stratum 5 is composed of very loose to firm silty SAND and SHELL (SM-SHELL) and soft to firm low and high plasticity silty CLAY (CL, CH) with trace shell fragments and is part of the Yorktown Formation. SPT resistances ranged from 0 to 18 bpf and averaged 6 bpf in this layer.

The CPT soundings at testing locations SCPTU-1 and SCPTU-2 extended to a depth of about 100 feet below existing grade. The soils between depths of about 40 to 100 feet are expected to be the Yorktown and St. Mary's Formations and were interpreted as interlayered loose to very dense sands and firm to very stiff silts and clays.

Figure 4 and Drawing 5 in Appendix A show a plot of the recorded SPT resistances with depth for the soil borings. The resistances are uncorrected and for an automatic hammer. The SPT is an index test

and the resistances can provide a generic indication of soil strength and compressibility.

Groundwater

The static groundwater table encountered after completion of the soil borings showed significant variation in depth and in approximate elevation across the site.

Measurements taken after boring completion indicated groundwater depths ranging from about 4 to 21 feet below the ground surface. Seven soil boring locations drilled to a depth of 20 feet below existing grade indicated dry conditions following drilling. One soil boring location drilled to a depth of 40 feet below existing grade caved at a depth of 8 feet and did not allow a groundwater table reading.

Groundwater depths measured after an approximate 24-hour and 48-hour stabilization period measured about 13 feet below existing grade at testing location P-1. Stabilized groundwater readings at testing location P-15 indicated the groundwater depth to be greater than 15 feet below existing grade. Stabilized groundwater readings at testing location P-6 were not possible due to the piezometer pipe being filled with soil due to caving.

The groundwater depth interpreted from pore pressure response at the SCPTU testing locations was approximately 30 feet below the ground surface. Groundwater measurement was not possible at the DMT locations due to caving soils, so these locations were assumed to have a groundwater depth similar to the nearby borings and/or SCPTU locations.

The measured groundwater depths represent the conditions encountered at the time of the exploration and do not necessarily indicate the water conditions that will be encountered during construction. Fluctuation in the water levels may occur due to variations in precipitation, evaporation, tides, construction activity, surface runoff and other local factors.

We expect the average groundwater table depths at the site to be located between 10 and 30 feet below the existing ground surface (at an average elevation ranging from approximately 30 to 50 feet taken from the provided topographic maps), depending on testing location. We expect these groundwater table depths will likely be relatively close to the normal seasonal low groundwater conditions for the site based on the time of year in which the borings were performed. Normal seasonal groundwater table fluctuations of 2 to 3 feet have been known to occur in parts of Hampton Roads.

Surface Materials

The existing ground surface at the majority of the boring locations was composed of approximately 2 to 8 inches of topsoil like material. Topsoil is a generic description meaning the surface soil horizon and does not imply the material is suitable for reuse on the project. Crushed stone of a thickness ranging from about 2 to 6 inches was encountered below the topsoil later at testing locations B-9 and P-20, located in existing greenspace. Asphalt thickness ranged from about 6 to 8 inches when encountered at testing locations P-11 and P-12 in the existing parking lot serving Gray Hall. Crushed stone measuring about 6 inches in thickness was encountered below the asphalt layer at testing location P-12. There was no stone layer encountered at testing location P-11. The thickness and composition of the surface materials can be expected to vary across the project limits.

Laboratory Testing

Appendix C of this report presents the results of the following geotechnical laboratory tests performed on selected disturbed soil samples recovered from the soil borings:

- 35 natural moisture content (ASTM D2216)
- 32 sieve analysis with #200 wash (ASTM D422, D1140)
- 28 Atterberg limits (ASTM D4318)
- 7 Standard Proctor moisture-density relationship (ASTM D698)
- 7 California Bearing Ratio, CBR (ASTM D1883)

Soil Permeability

Field saturated hydraulic conductivity, K_{fsat}, measured in the Stratum 1 clayey and clayey sand soils at the site at a depth ranging from about 2.5 to 4.5 feet below existing grade approached 0 inches per hour (i.e. impermeable). K_{fsat} in the Stratum 1 silty sand soils at the site at a depth ranging from about 4 to 4.5 feet below existing

grade measured about 1.5 to 3.5 inches per hour. Test results are provided in Appendix B.

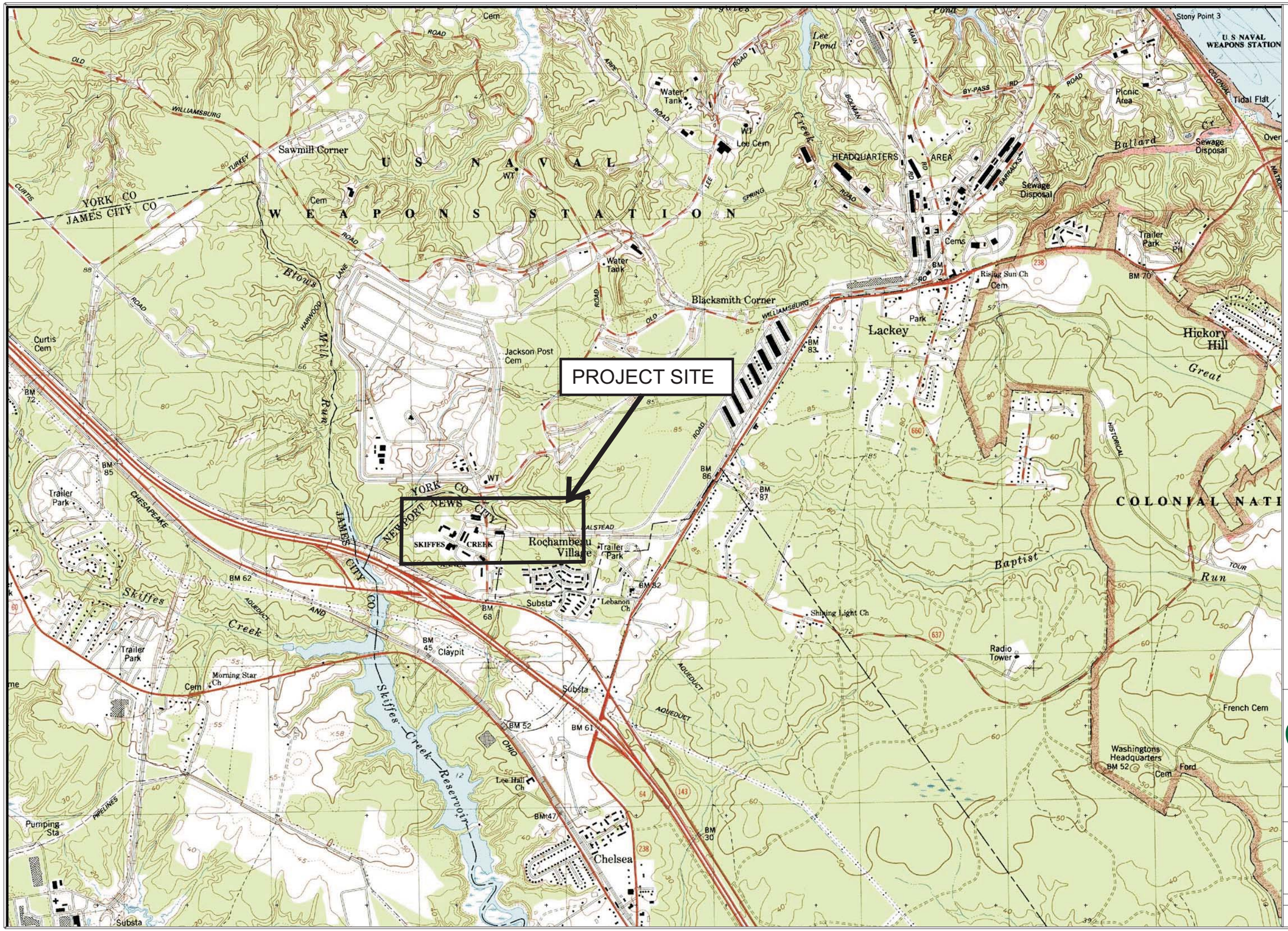
Limitations

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings, even a few feet away, will be materially different from the conditions encountered at the specific boring locations. In addition, soil and groundwater conditions may become altered by construction activity and the passage of time. These possibilities should be considered by the designers and contractors. Unanticipated conditions should be reported to the design team along with timely recommendations to solve the problems encountered.

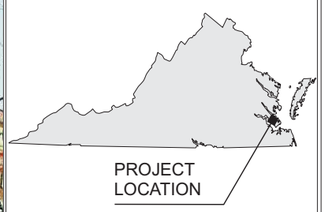
We have performed our services expressly for our client using that degree of care and skill ordinarily exercised under similar conditions by reputable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made. Third parties that rely on this report recognize that environmental and geologic conditions can vary from those encountered at the times and locations where data are obtained, and that the limitation on available data may result in some level of uncertainty with respect to the interpretation of those conditions, despite due professional care.

APPENDIX A

DRAWINGS



VICINITY MAP



SOURCE:

USGS Virginia Beach Yorktown

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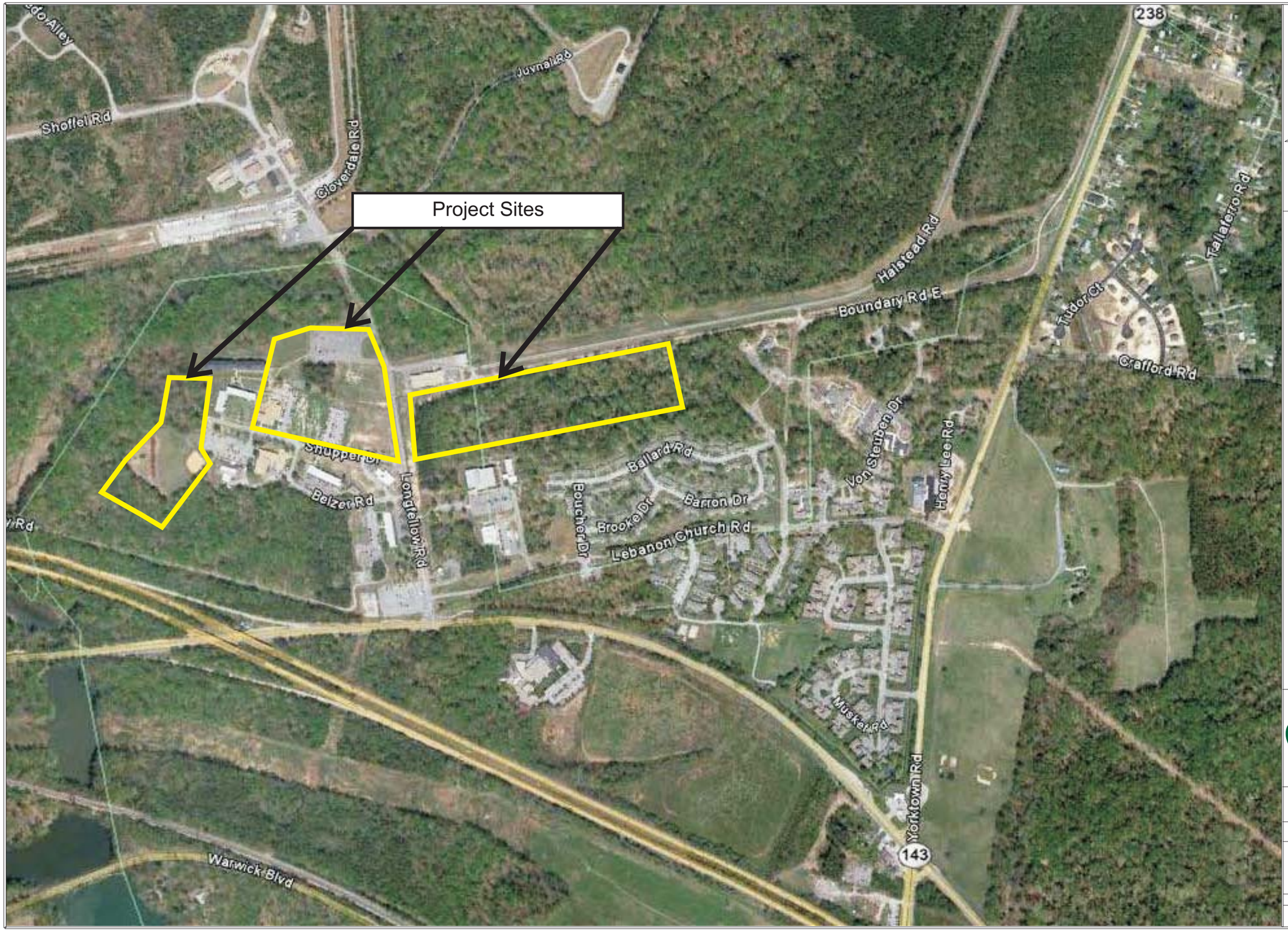
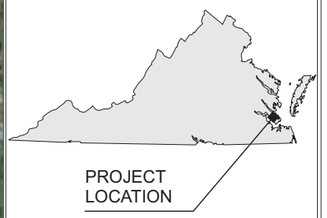
SITE VICINITY PLAN

P984-P989 MCSFRC Phase I
NWS Yorktown, VA

PROJECT NUMBER	DRAWING NUMBER
110-5960	1



VICINITY MAP



SOURCE:

Google Earth

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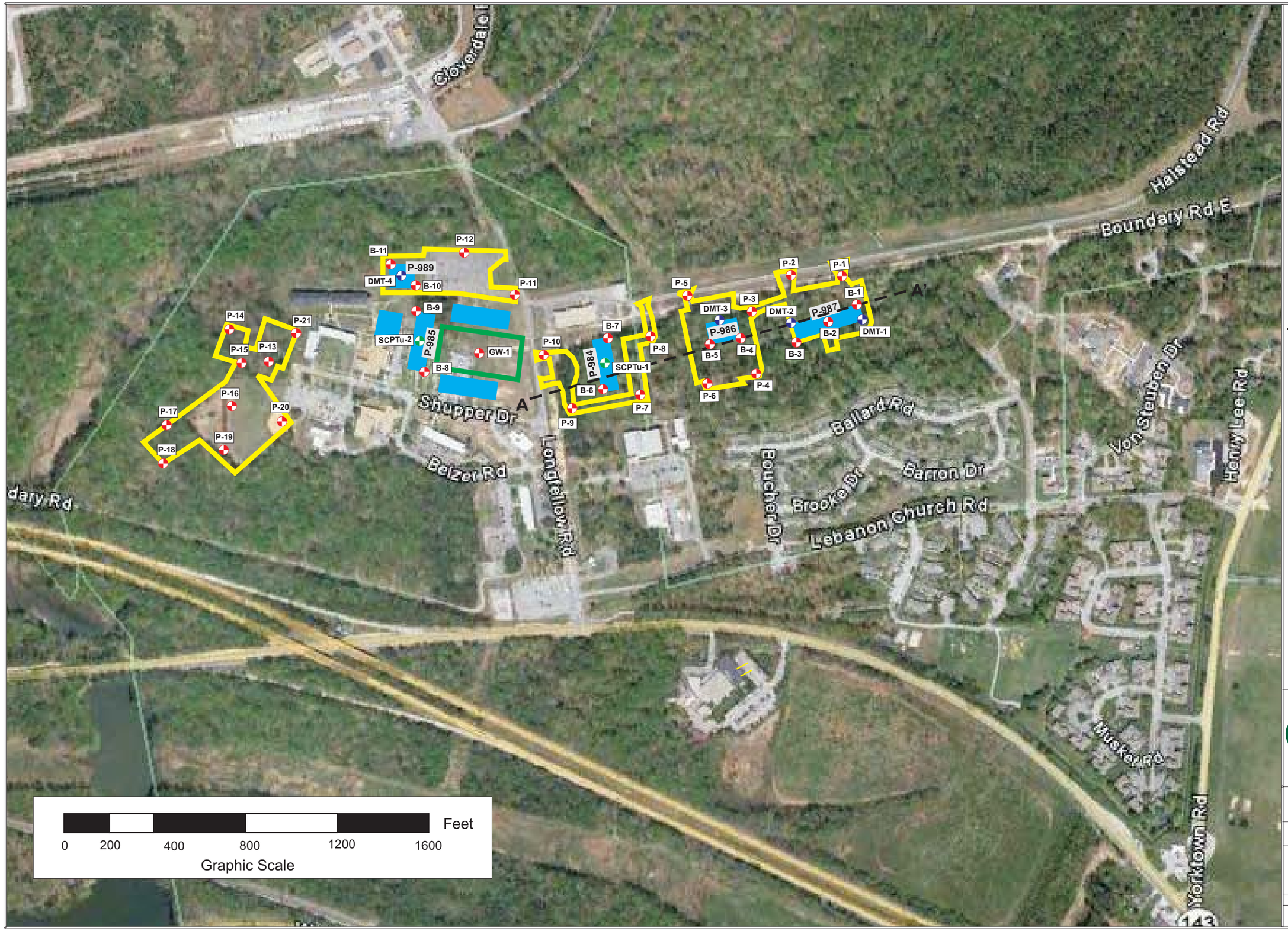
SITE LOCATION PLAN

P984-P989 MCSFRC, Phase I
NWS Yorktown, VA

PROJECT NUMBER	DRAWING NUMBER
110-5960	2



LEGEND:

- Approximate Soil Test Boring Location
- Approximate Seismic Cone Penetration Test (SCPTu) Sounding Location
- Approximate Dilatometer Test (DMT) Sounding Location
- Proposed Site Improvements
- Proposed Building
- Proposed Proving Ground
- Subsurface Profile Baseline on Drawing

SCALE:

Graphic As Shown

SHEET SIZE:

11" x 17"

NOTES:

Field testing locations were not surveyed and may be several feet from the locations indicated. The testing locations shown on this plan shall be considered approximate.

N

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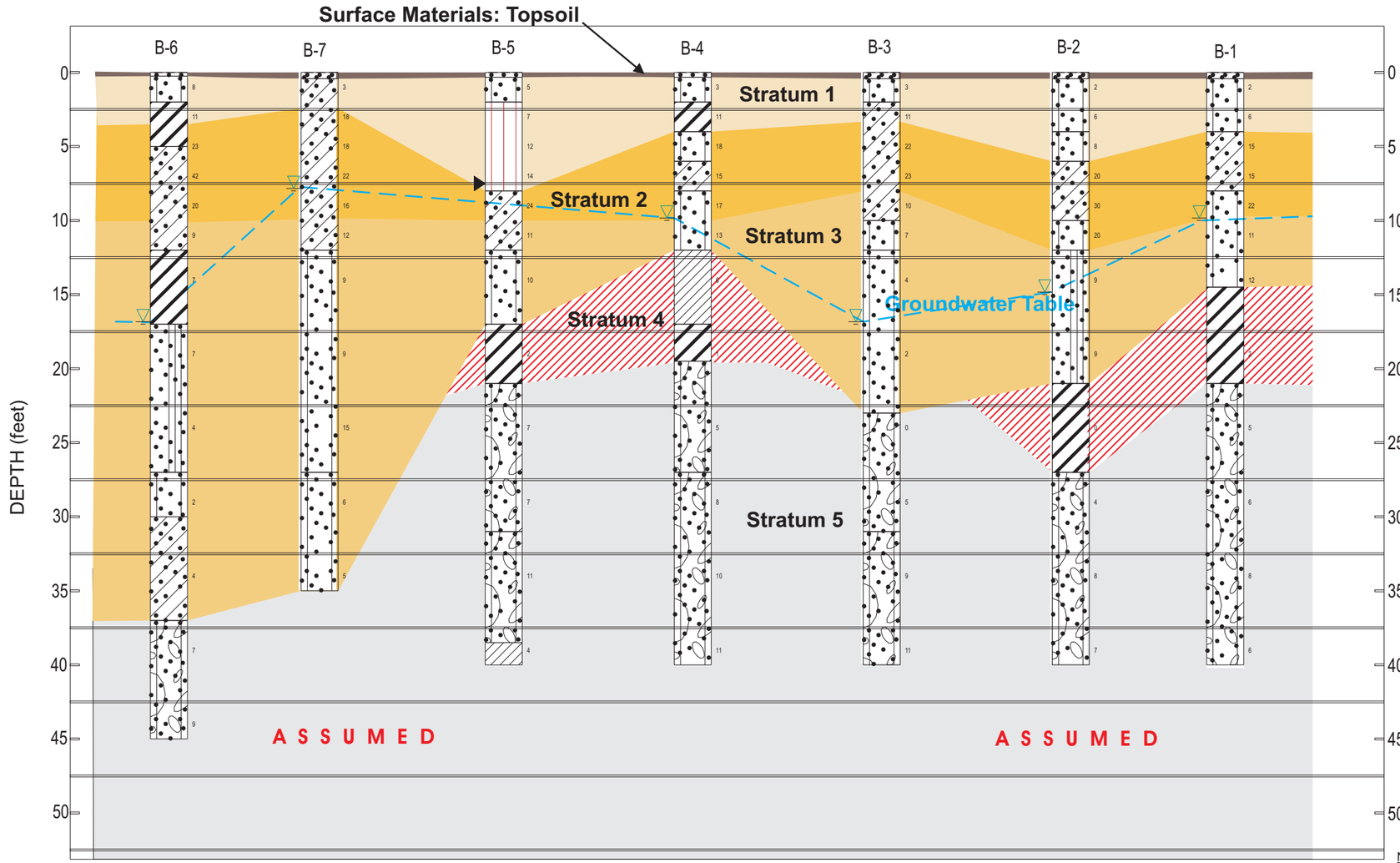
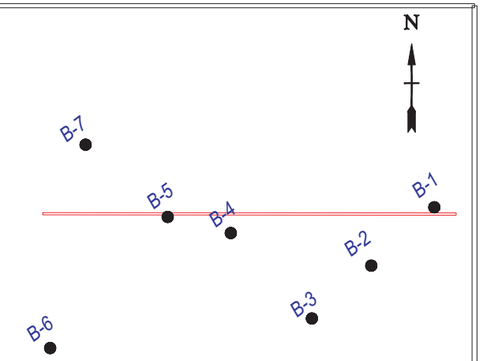
TESTING LOCATION PLAN

P984-P989 MCSFRC, Phase I
NWS Yorktown, VA

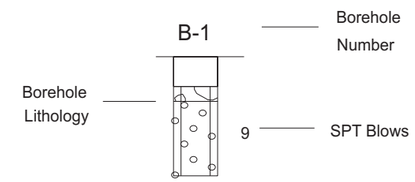
PROJECT NUMBER	DRAWING NUMBER
110-5941	3

11x17 3/12/12



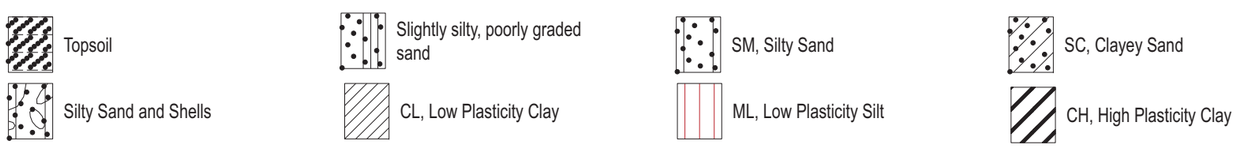


Explanation



Water Level Reading at time of drilling.

Lithology Graphics



NOTES:
The subsurface conditions presented are based on the data collected at specific boring locations only. Actual subsurface conditions will likely vary from those indicated.

Elevations and strata depths shall be considered approximate.

Stratum 1: Interlayered very loose to firm silty and clayey SAND and soft to very stiff low and high plasticity silty and sandy CLAY and low plasticity clayey SILT
Stratum 2: Interlayered firm to dense silty and clayey SAND and stiff to hard low and high plasticity silty and sandy CLAY and low plasticity clayey SILT
Stratum 3: Interlayered very loose to firm slightly silty, silty and clayey SAND and soft to stiff low and high plasticity silty and sandy CLAY and low and high plasticity clayey SILT
Stratum 4: Very soft to soft low and high plasticity silty and sandy CLAY and low plasticity clayey SILT
Stratum 5: Very loose to firm silty SAND and SHELL and soft to firm low and high plasticity silty CLAY with trace shell fragments (Yorktown Formation)

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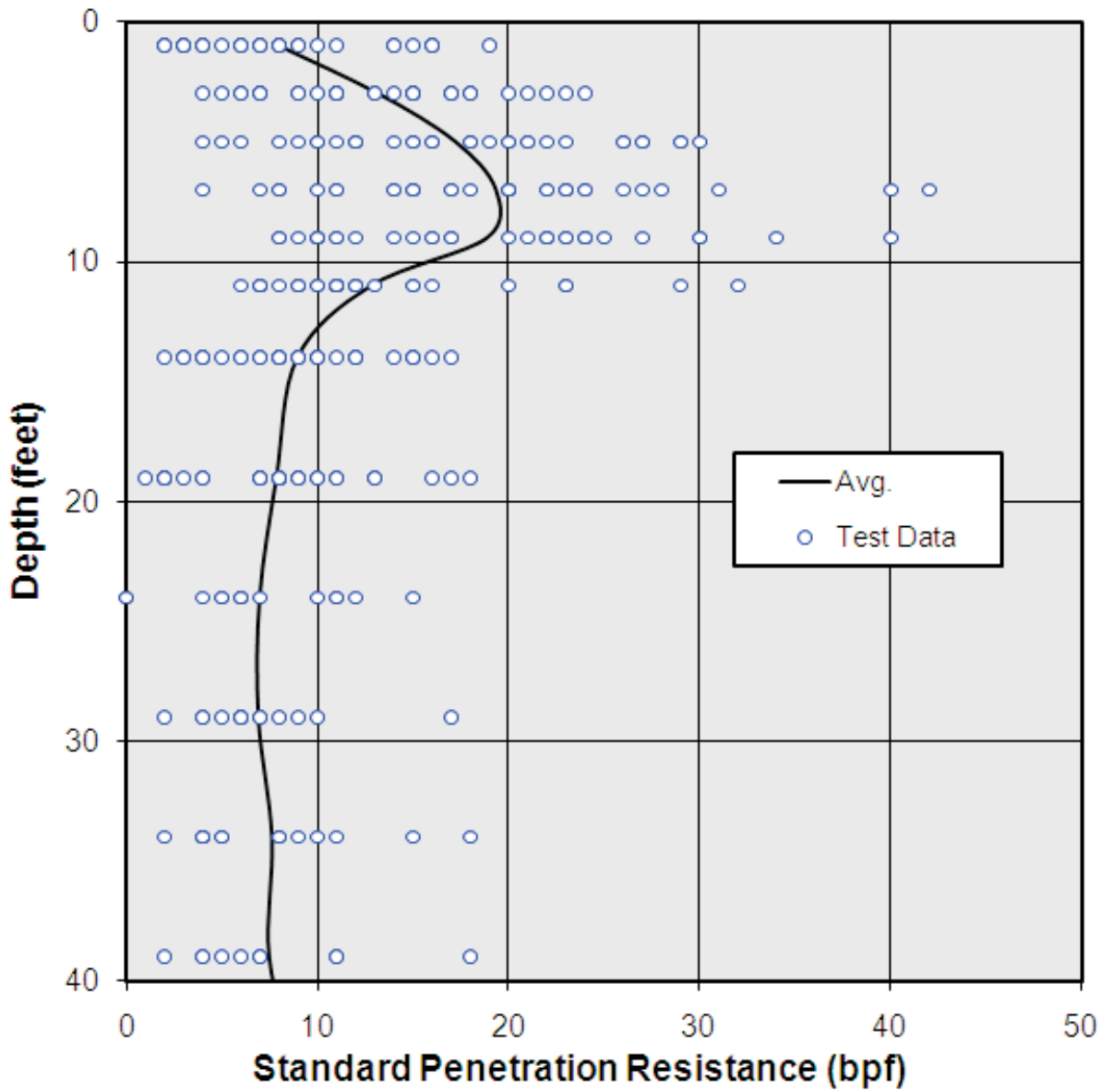
SUBSURFACE PROFILE:
HALSTEAD ROAD BUILDING LOCATIONS

P984-P989 MCSFRC, Phase I
NWS Yorktown, VA

PROJECT NUMBER	DRAWING NUMBER
110-5960	4



SPT resistances provide a generic indication of soil shear strength and compressibility parameters.

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SPT RESISTANCES

P-984 to P-989 MCSFRC Phase I
NWS Yorktown, VA

PROJECT NUMBER	DRAWING NUMBER
110-5960	5

APPENDIX B

FIELD TEST DATA

SUBSURFACE EXPLORATION PROGRAM SUMMARY

P984-P989 MCSFRC, Phase I
NWS Yorktown, VA
GER Project No. 110-5960

TEST LOCATION DATA

Test Location	Geographic Coordinates		Test Date	Test Depth (ft)	Surface Elevation (ft)	Notes
	Latitude	Longitude				
B-1	37.21613	-76.57767	6/27/2012	40	---	Target Depth
B-2	37.21600	-76.57830	6/27/2012	40	---	Target Depth
B-3	37.21588	-76.57872	6/27/2012	40	---	Target Depth
B-4	37.21619	-76.57980	6/26/2012	40	---	Target Depth
B-5	37.21609	-76.58019	6/26/2012	40	---	Target Depth
B-6	37.21576	-76.52814	6/22/2012	45	---	Target Depth
B-7	37.21622	-76.58190	6/25/2012	35	---	Target Depth
B-8	37.21646	-76.58512	6/20/2012	40	---	Target Depth
B-9	37.21719	-76.58498	6/18/2012	40	---	Target Depth
B-10	37.21752	-76.58497	6/18/2012	40	---	Target Depth
B-11	37.21781	-76.58507	6/18/2012	40	---	Target Depth
DMT-1	37.21600	-76.57766	6/26/2012	40	---	Target Depth
DMT-2	37.21611	-76.57874	6/27/2012	40	---	Target Depth
DMT-3	37.21626	-76.57994	6/26/2012	40	---	Target Depth
DMT-4	37.21759	-76.57990	6/27/2012	40	---	Target Depth
GW-1	37.21650	-76.58417	7/3/2012	250	---	Target Depth
P-1	37.21653	-75.96162	6/22/2012	20	---	Target Depth
P-2	37.21659	-75.96078	6/22/2012	20	---	Target Depth
P-3	37.21634	-75.96150	6/25/2012	20	---	Target Depth
P-4	37.21545	-75.96126	6/26/2012	35	---	Target Depth
P-5	37.21653	-75.96170	6/21/2012	20	---	Target Depth
P-6	37.21542	-75.96114	6/26/2012	35	---	Target Depth
P-7	37.21547	-75.96114	6/25/2012	35	---	Target Depth
P-8	37.21638	-75.96162	6/25/2012	20	---	Target Depth
P-9	37.21553	-75.96078	6/22/2012	20	---	Target Depth
P-10	37.21623	-75.96150	6/22/2012	20	---	Target Depth
P-11	37.21725	-75.96126	6/18/2012	20	---	Target Depth
P-12	37.21791	-75.96170	6/18/2012	20	---	Target Depth
P-13	37.21691	-75.96150	6/21/2012	20	---	Target Depth
P-14	37.21743	-75.96126	6/21/2012	20	---	Target Depth
P-15	37.21693	-75.96170	6/21/2012	20	---	Target Depth
P-16	37.21646	-75.96114	6/20/2012	20	---	Target Depth
P-17	37.21618	-75.96114	6/20/2012	20	---	Target Depth
P-18	37.21574	-75.96078	6/20/2012	20	---	Target Depth
P-19	37.21582	-75.96150	6/20/2012	20	---	Target Depth
P-20	37.21614	-75.96126	6/20/2012	20	---	Target Depth
P-21	37.21733	-75.96170	6/21/2012	20	---	Target Depth
SCPTu-1	37.21598	-75.96114	6/22/2012	100	---	Target Depth
SPCTu-2	37.21681	-75.96225	6/25/2012	100	---	Target Depth

NOTES:
Coordinates are WGS84 and shall be considered accurate to no more than 10 feet
Borings were field located using a handheld GPS device and were not physically surveyed
Test location ground elevations were not available at the time of the exploration

SUBSURFACE EXPLORATION PROGRAM SUMMARY

P984-P989 MCSFRC, Phase I
NWS Yorktown, VA
GER Project No. 110-5960

GROUNDWATER LEVEL OBSERVATIONS

Test Location	Measured Groundwater Depth (ft)					
	COB	6/22/2012	6/25/2012	6/26/2012	6/27/2012	7/13/2012
B-1	10.0	---	---	---	---	---
B-2	15.0	---	---	---	---	---
B-3	17.0	---	---	---	---	---
B-4	10.0	---	---	---	---	---
B-5	NE, caved	---	---	---	---	---
B-6	17.0	---	---	---	---	---
B-7	8.0	---	---	---	---	---
B-8	10.0	---	---	---	---	---
B-9	10.0	---	---	---	---	---
B-10	21.0	---	---	---	---	---
B-11	13.0	---	---	---	---	---
DMT-1	20.0, estimated	---	---	---	---	---
DMT-2	20.0, estimated	---	---	---	---	---
DMT-3	20.0, estimated	---	---	---	---	---
DMT-4	20.0, estimated	---	---	---	---	---
GW-1	n/a	---	---	---	---	---
P-1	18.0	---	10.0	13.0	---	13.0
P-2	18.0	---	---	---	---	---
P-3	18.0	---	---	---	---	---
P-4	10.0	---	---	---	---	---
P-5	19.0	---	---	---	---	---
P-6	8.0	---	---	---	caved	caved
P-7	9.0	---	---	---	---	---
P-8	15.0	---	---	---	---	---
P-9	NE	---	---	---	---	---
P-10	NE	---	---	---	---	---
P-11	6.0	---	---	---	---	---
P-12	3.5	---	---	---	---	---
P-13	3.0	---	---	---	---	---
P-14	NE	---	---	---	---	---
P-15	NE	15.0	15.0	---	---	NE
P-16	NE	---	---	---	---	---
P-17	NE	---	---	---	---	---
P-18	7.0	---	---	---	---	---
P-19	7.0	---	---	---	---	---
P-20	4.0	---	---	---	---	---
P-21	NE	---	---	---	---	---
SCPTu-1	30.0	---	---	---	---	---
SPCTu-2	30.0	---	---	---	---	---

NOTES:
Measurements in P-1, P-6 and P-15 were made in temporary piezometers set within the boreholes.
Groundwater depths are below existing ground surface.
COB denotes "Completion of Boring" and refers to the test date shown in the above table.
NE denotes "Not Encountered" and refers to the groundwater table not being present within the boring at the time of drilling.
Groundwater measurement changes may represent variations in precipitation, evaporation, etc.

TEST BORING RECORDS

The enclosed test boring records represent our interpretation of the subsurface conditions encountered at the specific boring locations at the time explorations were made based on visual examination of the field samples obtained and selected laboratory classification testing if performed. The lines designating the interface between various strata on the boring records represent the approximate interface location. In addition, the transition between strata may be more gradual than indicated. Water levels shown represent the conditions only at the time of the field exploration. It is possible that soil and groundwater conditions between the individual boring locations will be different from those indicated. Boring surface and strata elevations, if shown, shall be considered approximate and are referenced to project datum shown on the plans or described in the geotechnical report unless noted otherwise.

BORING LOG LEGEND

KEY TO DRILLING SYMBOLS

Split Spoon Sample (ASTM D 1586)		Water Table at Time of Drilling		**H.S.A.**	Hollow Stem Auger Drilling
Undisturbed Sample (ASTM D 1587)		Water Table after 24 hrs.		**M.R.**	Mud Rotary Wash Drilling
Rock Coring (ASTM D 2113)		Boring Cave In		**PP**	Pocket Penetrometer (tsf)
		Loss of Drilling Fluid		**REC**	Core Recovery (%)
		Auger Refusal		**RQD**	Rock Quality Designator (%)
Roller Cone Advanced		Roller Cone Refusal		**SCR**	Solid Core Recovery (%)
Seepage into Borehole	———	Approximate Strata Change Depth Different Soil Types	--------		Approximate Strata Change Depth Similar Soil Types

CORRELATION OF RELATIVE DENSITY AND CONSISTENCY WITH STANDARD PENETRATION TEST RESISTANCE (ASTM D 1586)[§]

SPT RESISTANCE (N) IN BLOWS PER FOOT

SPT N	RELATIVE DENSITY[†] SAND & GRAVEL	SPT N	CONSISTENCY[†] SILT & CLAY
0 - 4	Very Loose	0 - 2	Very Soft
5 - 10	Loose	3 - 4	Soft
11 - 30	Firm	5 - 8	Firm
31 - 50	Dense	9 - 15	Stiff
51 +	Very Dense	16 - 30	Very Stiff
		31 - 50	Hard
		51 +	Very Hard

ROCK QUALITY[‡]

FRACTURES, JOINT SPACING AND BEDDING

RQD (%)	DIAGNOSTIC DESCRIPTION	ROCK PARAMETER FIELD/LAB RATIO	SPACING	JOINTS	BEDDING
0 - 25	Very Poor	0.15	Less than 2"	Very Close	Very Thin
25 - 50	Poor	0.20	2" to 1'	Close	Thin
50 - 75	Fair	0.25	1' to 3'	Moderately Close	Medium
75 - 90	Good	0.30 to 0.70	3' to 10'	Wide	Thick
90 - 100	Excellent	0.70 to 1.00	More than 10'	Very Wide	Very Thick

HARDNESS

Very Hard - Breaking specimens requires several hard hammer blows

Hard - Hard hammer blow required to detach specimens

Moderately Hard - Light hammer blow required to detach specimens

Medium - May be scratched 1/16" deep by a knife or nail, breaks into several pieces by light hammer blow

Soft - Can be gouged readily by knife or nail, corners and edges broken by finger pressure

Very Soft - May be carved with a knife and readily broken by finger pressure

WEATHERING

Fresh - Fresh rock, bright crystals, no staining

Slight - Minimum stainaing and discoloration, open joints contain clay

Moderate - Significant portions of rock shows staining and discoloration, strong rock fragments

Severe - All rock shows staining, rock fabric evident but reduced strength

Very Severe - All rock shows staining, rock mass effectively reduced to soil with strong rock fragments remaining

Complete - Rock reduced to soil with rock fabric not discernable

[§] *Resistance of a standard 2-inch O.D., 1.375-inch I.D. split spoon sampler driven by a 140 pound hammer free-falling 30 inches.*

[†] *after Terzaghi and Peck, 1968*

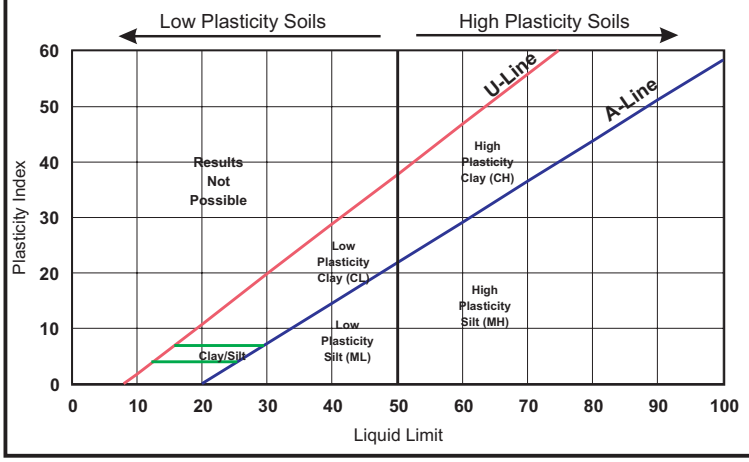
[‡] *after D. U. Deere, 1963, 1967*

GER

SOIL CLASSIFICATION CHART (ASTM D 2487)

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LOW PLASTICITY LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, CLAYEY SILTS, SILT-VERY FINE SAND MIXTURES, ROCK FLOUR
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, SILTY, & LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC CLAYS OF LOW PLASTICITY
		HIGH PLASTICITY LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS AND MICACEOUS, DIATOMACEOUS AND ELASTIC SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
OTHER SOILS	HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, MUCK, SWAMP SOILS WITH VERY HIGH ORGANIC CONTENTS
	UNCONTROLLED FILLS				DISTURBED SOILS WITH POSSIBLE DEBRIS AND RUBBLE, OLD CONSTRUCTION WASTES, NON-ENGINEERED BACKFILLS
	DECOMPOSED OR PARTIALLY WEATHERED ROCK				TRANSITIONAL MATERIAL BETWEEN SOIL AND ROCK WHICH MAY RETAIN THE RELICT STRUCTURE OF THE PARENT ROCK

Atterberg Limits



PARTICLE SIZE IDENTIFICATION

BOULDERS:		Greater than 300 mm (12 in.)
COBBLES:		75 mm to 300 mm (3 - 12 in.)
GRAVEL:	Coarse -	19.0 mm to 75 mm (0.75 - 3 in.)
	Fine -	4.75 mm to 19.0 mm (#4 - 0.75 in.)
SANDS:	Coarse -	2.00 mm to 4.75 mm
	Medium -	0.425 mm to 2.00 mm
	Fine -	0.075 mm to 0.425 mm
SILTS & CLAYS:		Less than 0.075 mm

PLASTICITY INDEX (PI) & SHRINK-SWELL POTENTIAL

0 - 4	None
4 - 15	Slight or Low
15 - 30	Medium to High
31+	High to Very High

ADDITIONAL RELATIVE DESCRIPTIVE VALUES

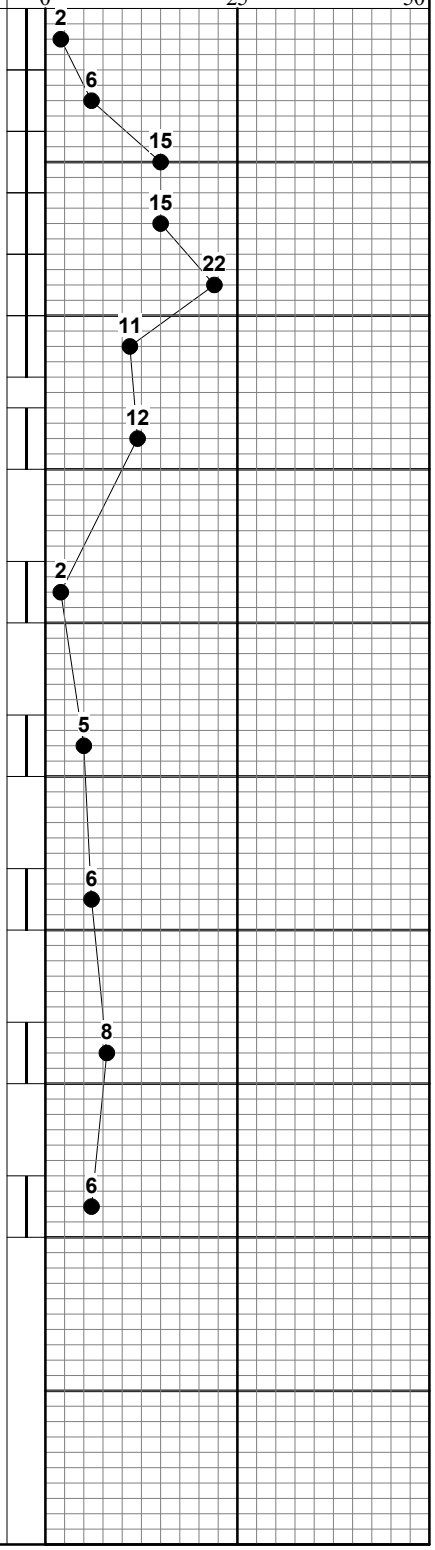
Trace < 10%	Some < 35% but > 20%
Little < 20% but > 10%	And > 35%

GER

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-1**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/27/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			
			1		**Silty SAND (SM)** Very loose to loose, fine to medium, gray and brown			1 1 1 1 1 3 3 3 3 3
		5	2		**Clayey SAND (SC)** Firm, fine to medium, orange and gray			5 6 9 9 6 6 9 11 9 11 11 13
		10	3		**Silty SAND (SM)** Firm to loose, fine to coarse, orange and red	▽		4 4 7 8
			4					7 6 6 5
		15	5		**Sandy, High Plasticity CLAY (CH)** Very soft, orange			1 1 1 1 1
		20	6				PP=0.125 tsf	
			7		**Silty SAND and SHELL (SM-SHELL)** Loose, fine to medium, orange and gray, Yorktown Formation			2 2 3 3
		25	8					
		30	9					3 3 3 3
			10					3 3 5 5
		35	11					
		40	12					2 3 3 4
					Boring terminated at 40 feet.			
			13					
		45	14					
			15					



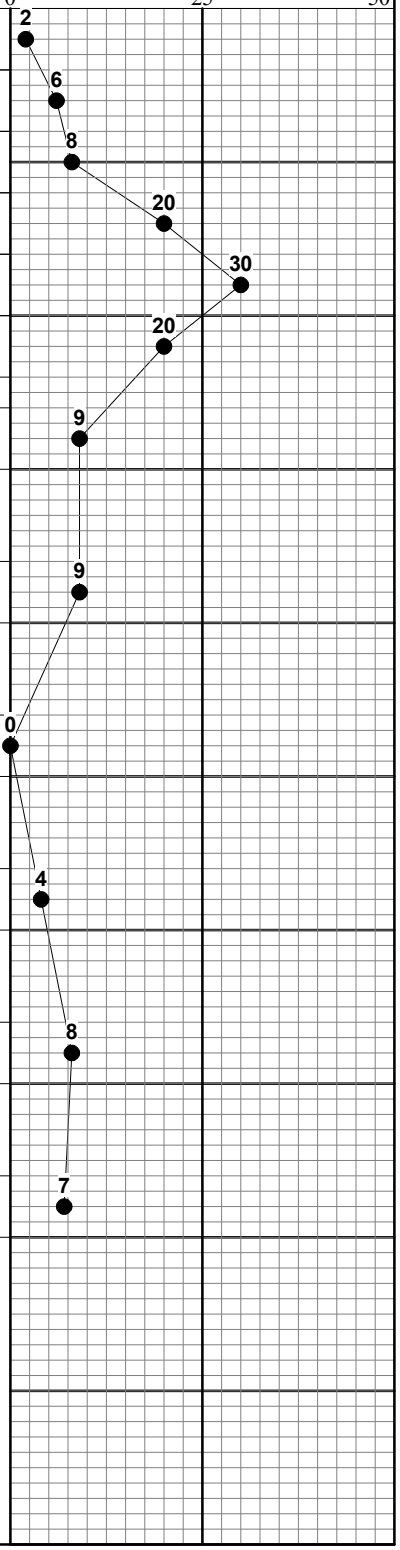
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-2**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/27/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			
					Silty SAND (SM) Very loose to loose, fine to medium, brown			1 1 1 2 3 3 3 4
			1					
		5			**Silty SAND (SM)** Loose, fine to medium, brown and orange, with trace clay			2 3 5 7 9 10 10 11 13 15 15 18
			2		**Clayey SAND (SC)** Firm, fine to medium, orange, gray and brown			
		10	3		**Silty SAND (SM)** Firm, fine to medium, gray			8 10 10 11
			4		**Slightly Silty SAND (SP-SM)** Loose, fine to coarse, brown and gray, with trace clay	▽		4 4 5 6
		15	5					2 4 5 4
		20	6					
			7		**Silty, High Plasticity CLAY (CH)** Very soft, brown and orange		PP=0.094 tsf	0 0 0 0
		25	8					
			9		**Silty SAND and SHELL (SM-SHELL)** Very loose to loose, fine to medium, orange and gray, Yorktown Formation			3 2 2 3
		30	10					4 4 4 4
		35	11					
			12					4 3 4 4
		40			Boring terminated at 40 feet.			
			13					
		45	14					
			15					

Uncorrected Penetration Resistance (blows/foot)



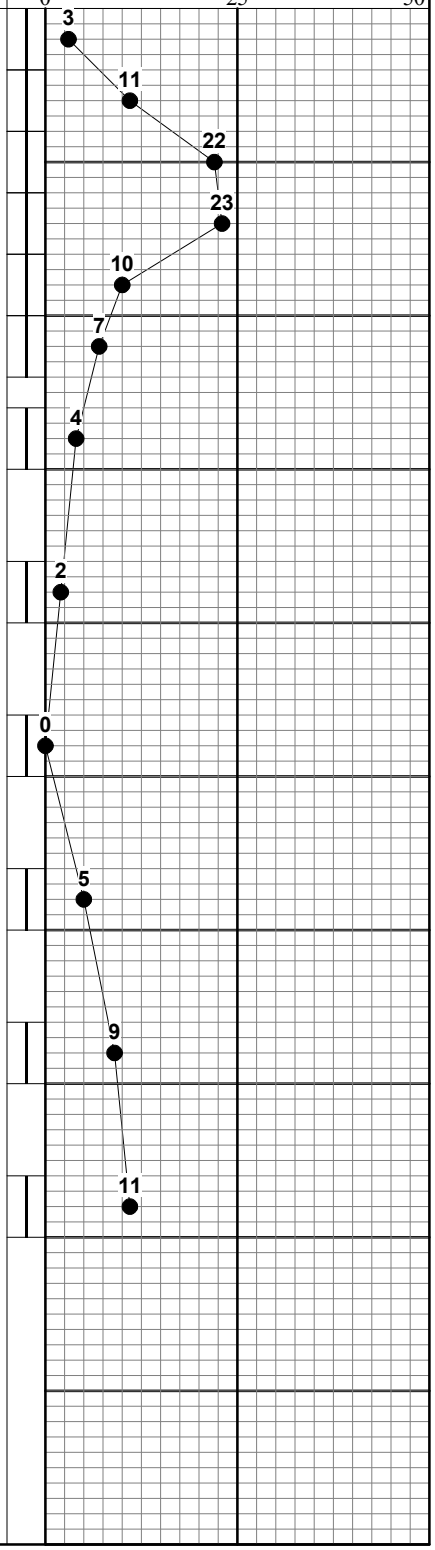
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-3**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/27/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			1 1 2 2
					Silty SAND (SM) Very loose, fine to medium, brown			4 4 7 8
			1		**Clayey SAND (SC)** Firm to loose, fine to medium, orange, gray and brown			10 11 11 13
		5						11 11 12 13
			2					6 5 5 7
		10	3		**Silty SAND (SM)** Loose, fine to medium, orange and brown			4 4 3 3
					Silty SAND (SM) Very loose, fine to medium, orange and brown, with trace clay			2 2 2 2
			4					
		15						
			5			▽		1 1 1 1
		20	6					
			7		**Silty SAND and SHELL (SM-SHELL)** Very loose to loose, fine to medium, orange, Yorktown Formation			0 0 0 0
		25						
			8					1 1 4 5
		30	9					
					Silty SAND and SHELL (SM-SHELL) Loose to firm, fine to medium, gray, Yorktown Formation			
			10					5 4 5 5
		35						
			11					4 5 6 7
		40	12		Boring terminated at 40 feet.			
			13					
		45						
			14					
			15					

Uncorrected Penetration Resistance (blows/foot)



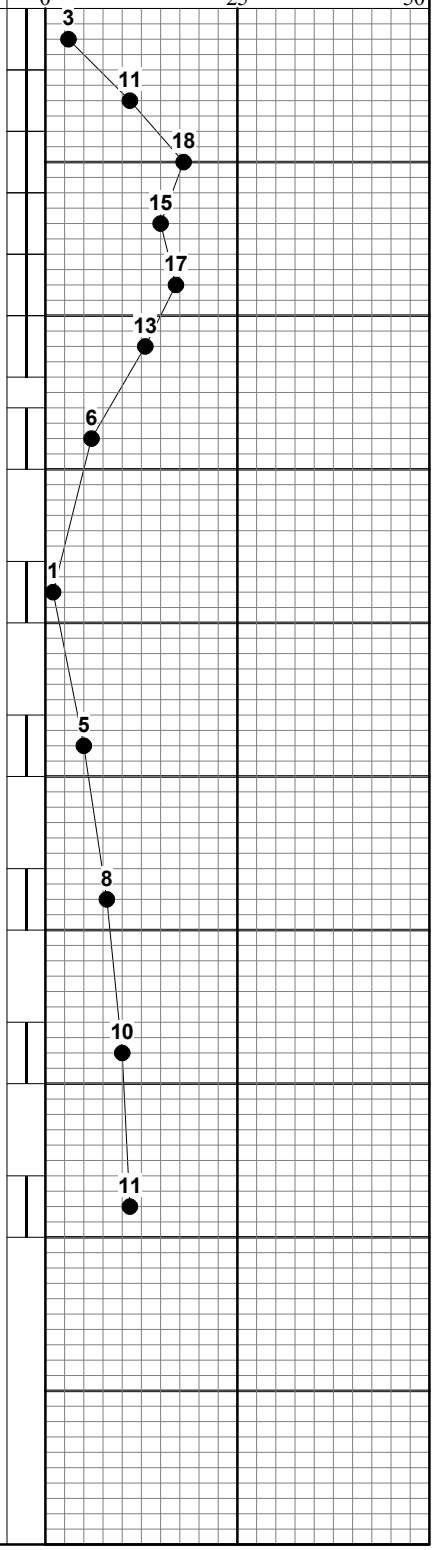
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-4**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/26/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			1 1 2 2
					Silty SAND (SM) Very loose, fine to medium, brown			4 4 7 7
			1		**Sandy, High Plasticity CLAY (CH)** Firm, orange and gray		PP=2.5 tsf	9 9 9 10
		5			**Silty SAND (SM)** Firm, fine to medium, orange and gray			8 8 7 7
			2		**Clayey SAND (SC)** Firm, fine to medium, orange			8 8 9 9
					Silty SAND (SM) Firm, fine to medium, orange			9 7 6 5
		10	3			▽		
			4		**Sandy, Low Plasticity CLAY (CL)** Loose, gray and orange			2 3 3 3
		15					PP=1.5 tsf	
			5					
					Silty, High Plasticity CLAY (CH) Very soft, orange			0 0 1 1
		20	6		**Silty SAND and SHELL (SM-SHELL)** Loose, fine to medium, orange and gray, Yorktown Formation		PP=0.078 tsf	
			7					3 3 2 2
		25	8					
					Silty SAND and SHELL (SM-SHELL) Loose to firm, fine to medium, gray, Yorktown Formation			3 4 4 4
		30	9					
			10					3 6 4 5
		35	11					
			12					6 5 6 6
		40			Boring terminated at 40 feet.			
			13					
		45	14					
			15					

Uncorrected Penetration Resistance (blows/foot)

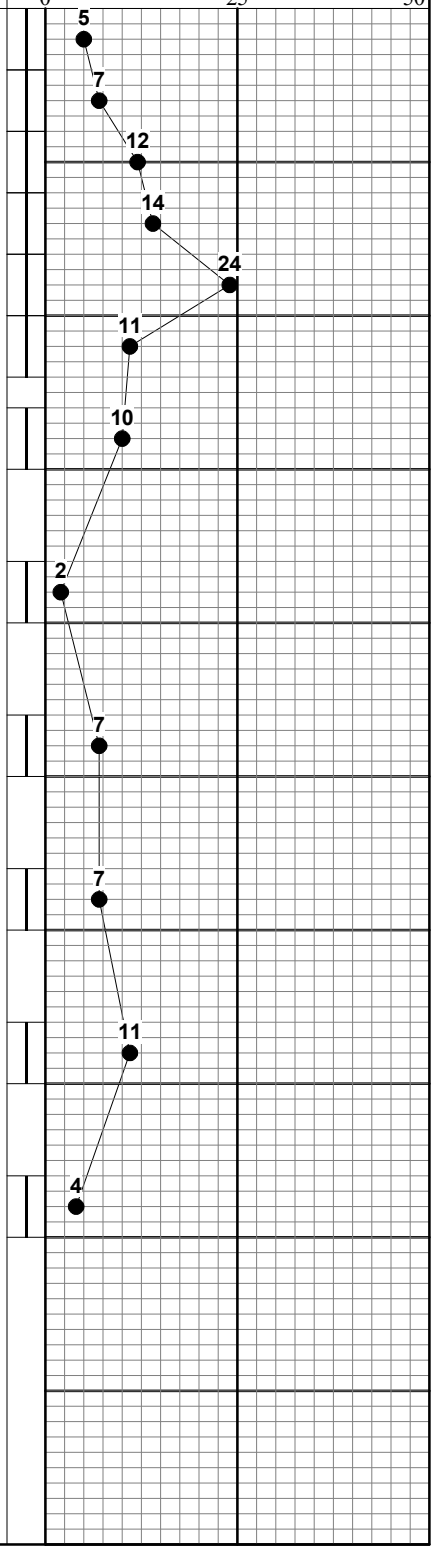


TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-5**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/26/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			2 2 2 3
					Silty SAND (SM) Loose, fine to medium, brown			2 3
			1		**Low Plasticity Sandy SILT (ML)** Firm to stiff, brown, orange and gray			3 4 3
		5						2 4 8
			2					7 6 7
								7 8
					Clayey SAND (SC) Firm, fine to medium, gray and orange			11 12 12 13
		10	3					4 5 6 7
					Silty SAND (SM) Loose, fine to medium, brown and orange			4 5 5 6
		15	4					
			5		**Sandy, High Plasticity CLAY (CH)** Very soft, brown and orange			1 1 1 1
		20	6				PP=0.219 tsf	
					Silty SAND and SHELL (SM-SHELL) Loose, fine to medium, orange and gray, Yorktown Formation			4 5 2 2
		25	7					
			8					4 4 3 5
		30	9					
					Silty SAND and SHELL (SM-SHELL) Firm, fine to medium, gray, Yorktown Formation			6 6 5 5
			10					
		35	11					
			12		**Silty, Low Plasticity CLAY (CL)** Soft, gray, with trace shell fragments			2 2 2 3
		40			Boring terminated at 40 feet.			
			13					
		45	14					
			15					

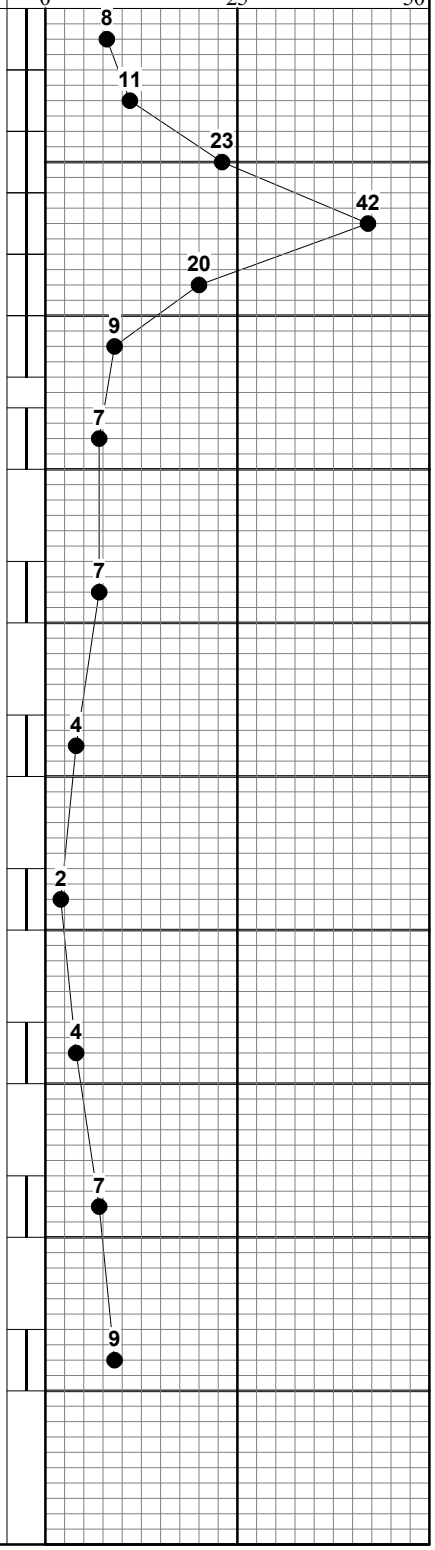


TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-6**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/22/2012**
Depth (ft.): **45.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					3 inches TOPSOIL			3 5 3 3
					Silty SAND (SM) Loose, fine to medium, brown			3 4 7 10
			1		**Sandy, High Plasticity CLAY (CH)** Firm, brown, orange and gray		PP=3.5 tsf	11 11 12 13
		5			**Clayey SAND (SC)** Dense to loose, fine to medium, gray and orange		PP=2.5 tsf	20 21 21 22
			2					11 10 10 9
		10	3					5 4 5 6
			4		**Silty, High Plasticity CLAY (CH)** Firm, red and orange		PP=2.0 tsf	4 4 3 5
		15	5			▽		
			6		**Slighlty Silty SAND (SP-SM)** Loose to very loose, fine to medium, orange, gray and red			4 4 3 4
		20						
			7					3 2 2 3
		25	8					
					Silty SAND (SM) Very loose, fine to coarse, orange and red			2 1 1 2
		30	9					
					Clayey SAND (SC) Very loose, fine to medium, gray, with trace to little shell fragments			2 2 2 2
			10					
		35	11					
					Silty SAND and SHELL (SM-SHELL) Loose, fine to medium, orange, Yorktown Formation			3 3 4 5
		40	12					
			13					5 4 5 5
		45			Boring terminated at 45 feet.			
			14					
			15					



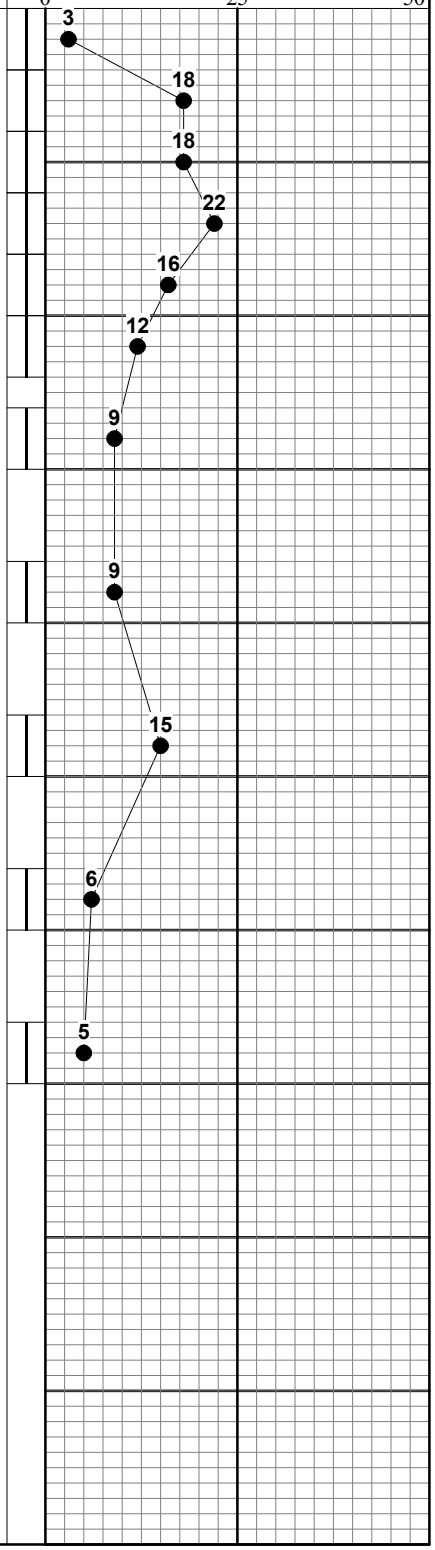
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-7**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/25/2012**
Depth (ft.): **35.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			
					Clayey SAND (SC) Very loose to firm, fine to medium, orange and red	▽		1 1 2 2 7 8 10 10 8 9 9 11 9 11 11 11 7 8 8 6 3 5 7 7
					Silty SAND (SM) Loose to firm, fine to medium, orange, gray and brown, with trace clay			3 4 5 5 4 4 5 6 6 7 8 11
					Silty SAND (SM) Loose, fine to coarse, orange, with trace clay			6 4 2 2 3 2 3 2
					Boring terminated at 35 feet.			

Uncorrected Penetration Resistance (blows/foot)

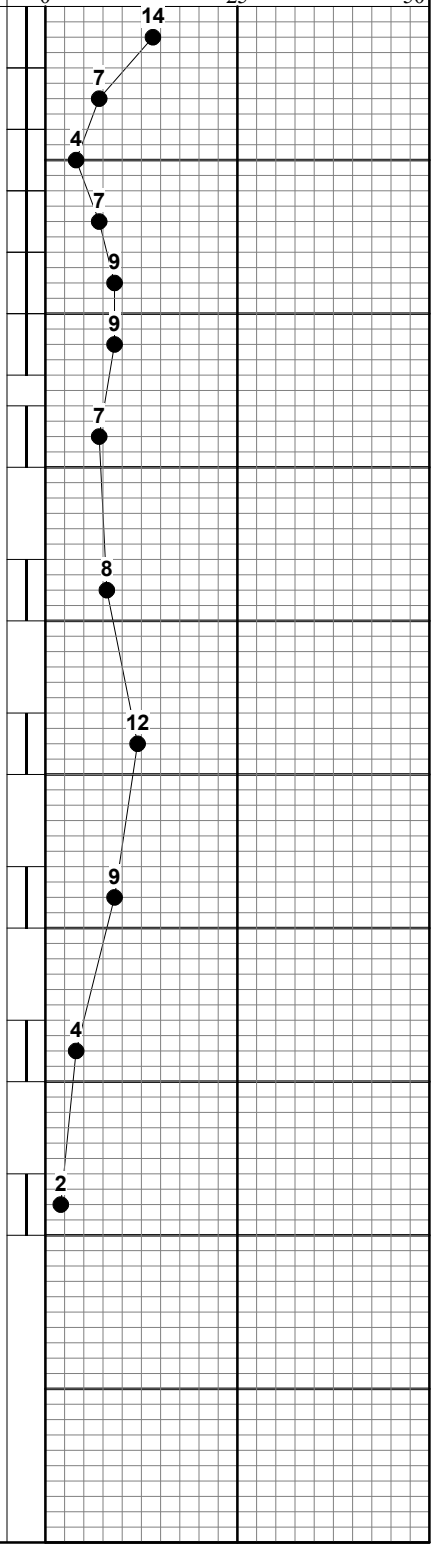


TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-8**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/20/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					3 inches TOPSOIL			
					Silty SAND (SM) Firm to loose, fine to medium, brown and orange, with trace gravel and trace clay			
			1		**Silty, Low Plasticity CLAY (CL)** Firm to soft, brown, orange, brown and gray		PP=1.25 tsf	3 9 5 5
		5					PP=1.5 tsf	3 3 4 3
			2				PP=1.5 tsf	3 2 2 2
					Sandy, Low Plasticity CLAY (CL) Stiff to firm, orange and gray			3 3 4 6
		10	3			▽	PP=3.5 tsf	3 3 6 7
							PP=3.5 tsf	2 4 5 7
			4				PP=1.5 tsf	2 3 4 6
		15						
			5					
		20	6				PP=1.5 tsf	3 3 5 5
					Clayey SAND (SC) Firm, fine to medium, orange			
			7					5 6 6 7
		25						
			8					
					Sandy, High Plasticity CLAY (CH) Stiff to soft, brown, orange			2 5 4 4
		30	9					
			10					2 2 2 3
		35					PP=1.25 tsf	
			11					
					Silty, Low Plasticity CLAY (CL) Very soft, gray			1 1 1 2
			12				PP=1.25 tsf	
		40			Boring terminated at 40 feet.			
			13					
		45						
			14					
			15					



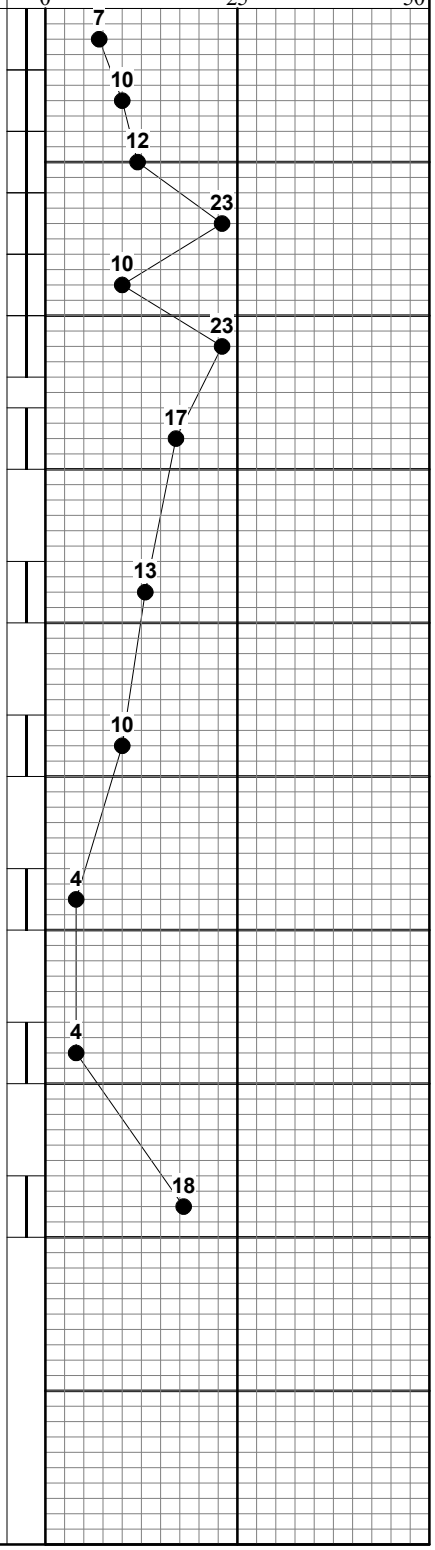
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-9**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/18/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			7 4 3 5
					2 inches CRUSHED STONE			
					Sandy, Low Plasticity CLAY (CL) Firm to stiff, orange and brown		PP=1.0 tsf	7 4 6 7
		5	1				PP=1.0 tsf	4 4 8 8
			2		**Silty, Low Plasticity CLAY (CL)** Very stiff, orange		PP=1.75 tsf	10 11 12 12
					Sandy, Low Plasticity CLAY (CL) Stiff to very stiff, orange and gray			3 4 6 8
		10	3			▽	PP=1.75 tsf	9 12 11 13
			4				PP=2.5 tsf	
		15	5		**Silty SAND (SM)** Firm, fine to medium, orange and gray, with trace clay			5 7 10 10
					Clayey SAND (SC) Firm, fine to medium, orange and gray			6 5 8 10
		20	6					
					Sandy, Low Plasticity CLAY (CL) Stiff to soft, orange			
			7					4 5 5 6
		25					PP=0.5 tsf	
			8					1 1 3 5
		30	9				PP=0.75 tsf	
					Silty SAND and SHELL (SM-SHELL) Loose to firm, fine to medium, orange and gray, Yorktown Formation			
			10					1 1 3 4
		35	11					
								7 9 9 9
		40	12					
					Boring terminated at 40 feet.			
			13					
		45	14					
			15					

Uncorrected Penetration Resistance (blows/foot)



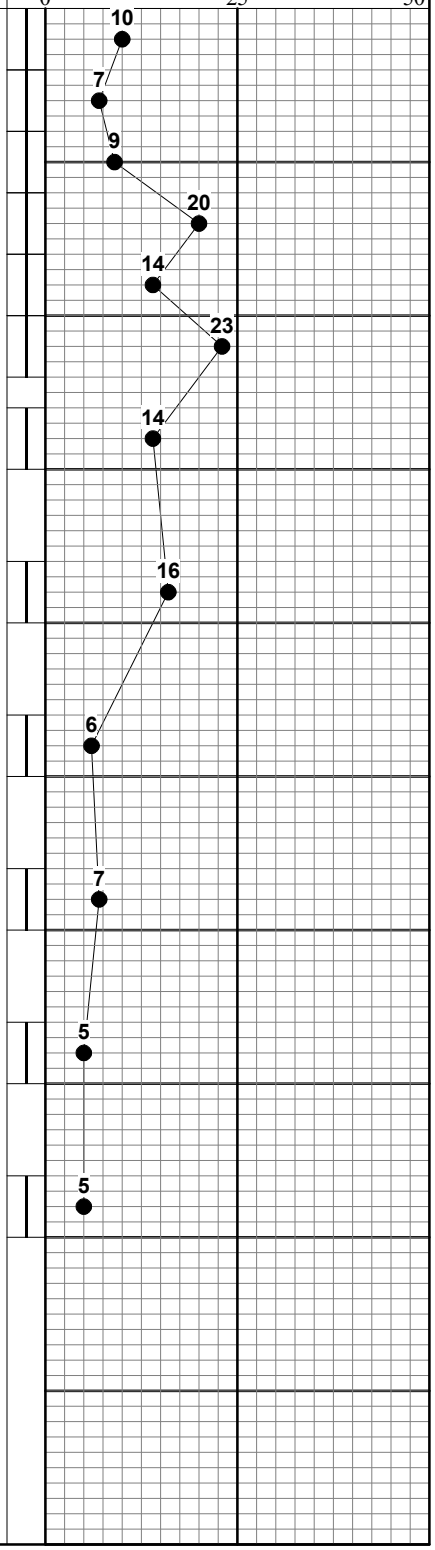
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-10**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/18/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments
					4 inches TOPSOIL		
			1		**Silty SAND (SM)** Loose, fine to medium, brown		
		5	2		**Sandy, Low Plasticity CLAY (CL)** Stiff to very stiff, orange and brown		PP=3.5 tsf
		10	3		**Clayey SAND (SC)** Firm, fine to medium, orange		
		15	4				
			5		**Silty SAND (SM)** Firm, fine to medium, brown and black		
		20	6			▽	
			7		**Sandy, High Plasticity CLAY (CH)** Firm, orange		PP=0.25 tsf
		25	8				
		30	9		**Silty SAND and SHELL (SM-SHELL)** Loose, fine to medium, gray, Yorktown Formation		
			10				
		35	11				
			12		**Silty, High Plasticity CLAY (CH)** Firm, gray, with trace shell fragments		
		40			Boring terminated at 40 feet.		
		45	13				
			14				
			15				

SPT: 5 5 5 5 4 4 3 4 4 4 5 7 5 10 10 13 4 7 7 8 10 11 12 11 4 7 7 8 7 8 8 7 3 3 3 4 4 4 3 4 3 3 2 2 2 2 3 2



TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

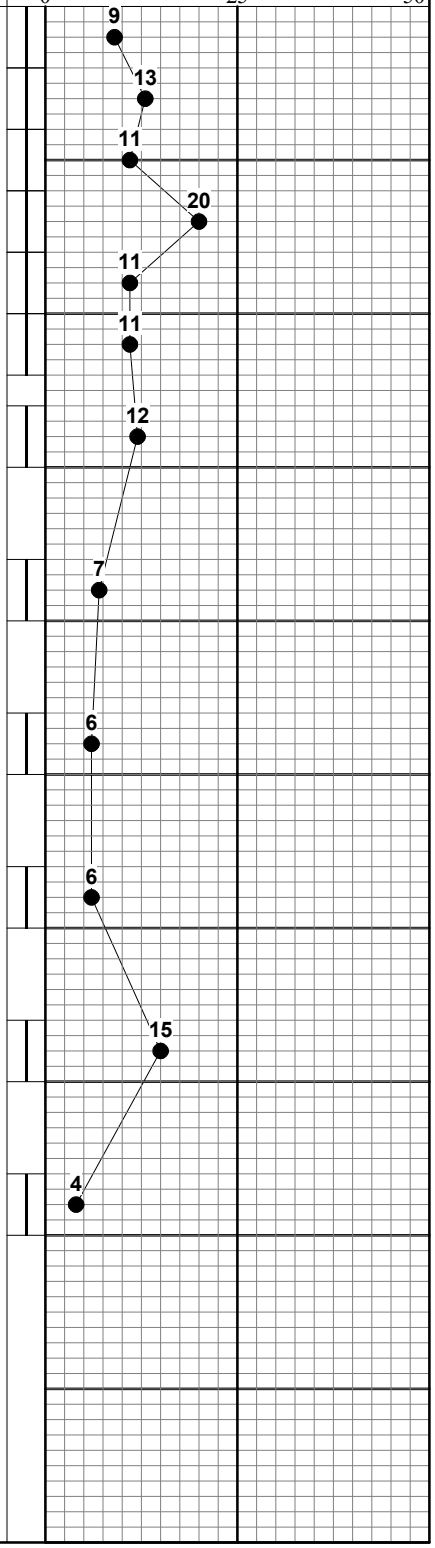
TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **B-11**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/18/2012**
Depth (ft.): **40.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Material Description	Comments
3 inches TOPSOIL	
Clayey SAND (SC) Loose to firm, fine to medium, brown and gray	PP=3.5 tsf
Sandy, Low Plasticity CLAY (CL) Very stiff, orange	
Clayey SAND (SC) Firm, fine to medium, orange	
Silty SAND (SM) Firm, fine to coarse, orange and black	
Clayey, High Plasticity SILT (MH) Firm, orange	PP=0.5 tsf
Silty SAND (SM) Loose, fine to coarse, brown, with some shell fragments	
Silty SAND and SHELL (SM-SHELL) Loose to firm, fine to medium, brown, Yorktown Formation	
Silty, High Plasticity CLAY (CH) Soft, gray, with trace shell fragments	PP=0.094 tsf
Boring terminated at 40 feet.	

Ground Water: ▽

SPT Penetration Resistance (blows/foot): 9, 13, 11, 20, 11, 11, 12, 7, 6, 6, 15, 4



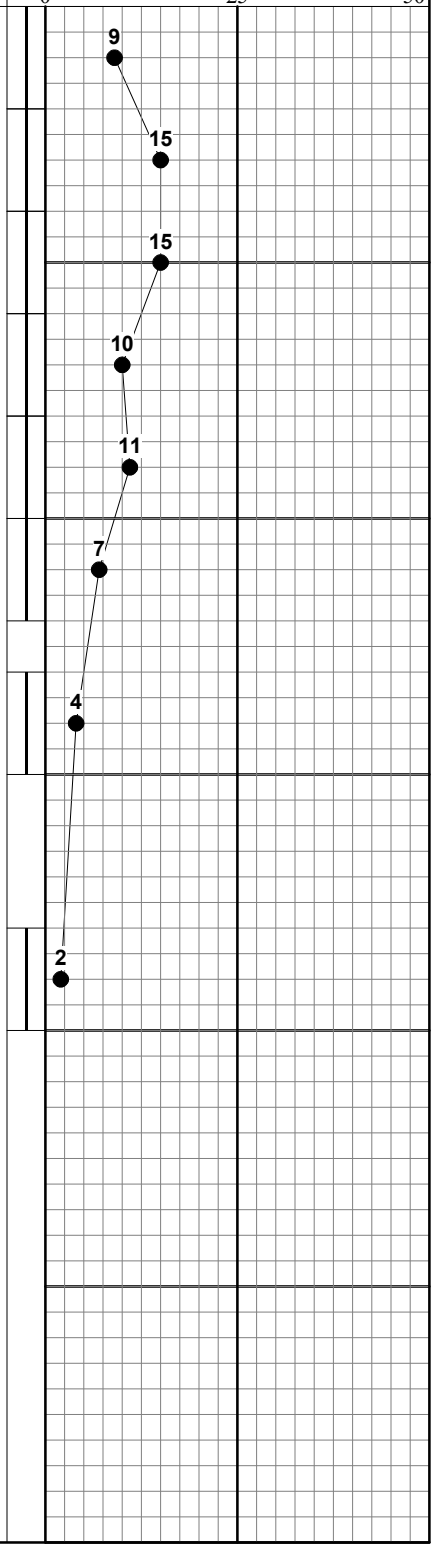
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-1**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/22/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			0
					Clayey SAND (SC) Loose to firm, fine to medium, orange and gray			3 6 7 7 7 8 9 6 7
		5	1		**Silty SAND (SM)** Firm, fine to medium, orange, with trace clay			8 9
			2		**Clayey SAND (SC)** Loose, fine to medium, orange			5 5
					Sandy, Low Plasticity CLAY (CL) Stiff, orange		PP=1.75 tsf	5 5 4 5 6 6
		10	3		**Clayey SAND (SC)** Loose, fine to medium, orange			4 4 3 4
					Sandy, Low Plasticity CLAY (CL) Soft, orange			2 2 2 2
		15	4					
			5		**Silty SAND (SM)** Very loose, fine to coarse, orange	▽		1 1
		20	6		**Sandy, Low Plasticity CLAY (CL)** Soft, orange, with trace shell fragments (Yorktown Formation)		PP=0.75 tsf	1 2
					Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



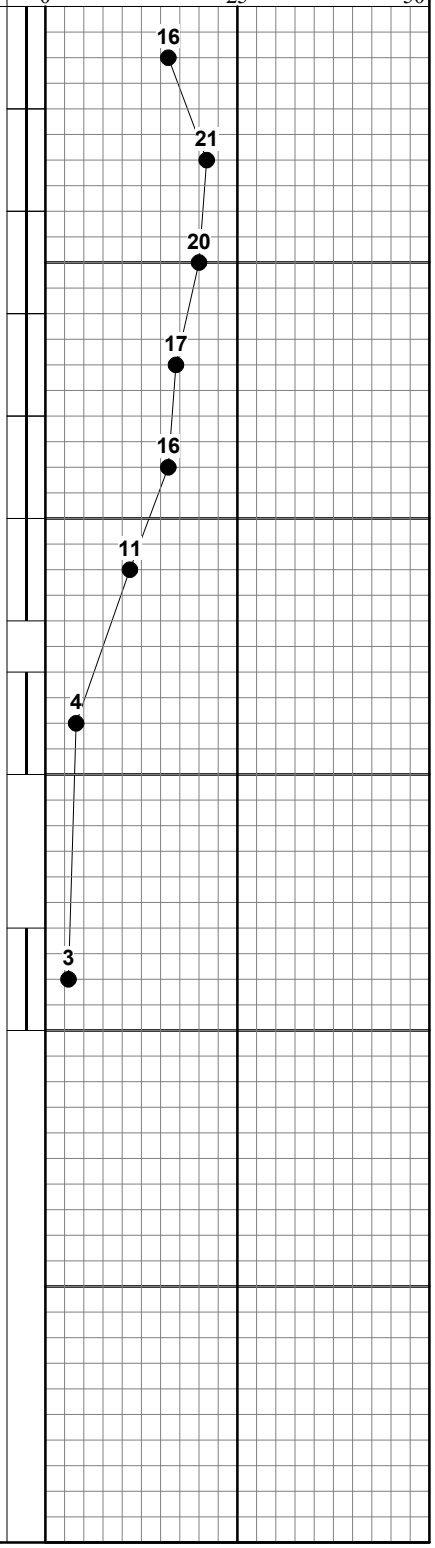
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-2**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/22/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			
					Silty SAND (SM) Firm, fine to medium, brown and orange			5, 6, 10, 10
			1		**Clayey SAND (SC)** Firm, fine to medium, orange and gray, with trace clay			9, 10, 11, 11, 11, 10
		5			**Slightly Silty SAND (SP-SM)** Firm, fine to medium, orange			10, 9
			2		**Silty SAND (SM)** Firm, fine to coarse, orange and gray, with trace clay			12, 8, 9, 9, 9, 8, 8, 9
		10	3		**Sandy, Low Plasticity CLAY (CL)** Stiff, orange		PP=1.0 tsf	3, 5, 6, 7
			4		**Silty, High Plasticity CLAY (CH)** Soft, orange and brown		PP=0.75 tsf	2, 2, 2, 2
		15	5			▽		
							PP=0.25 tsf	1, 1, 2, 2
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



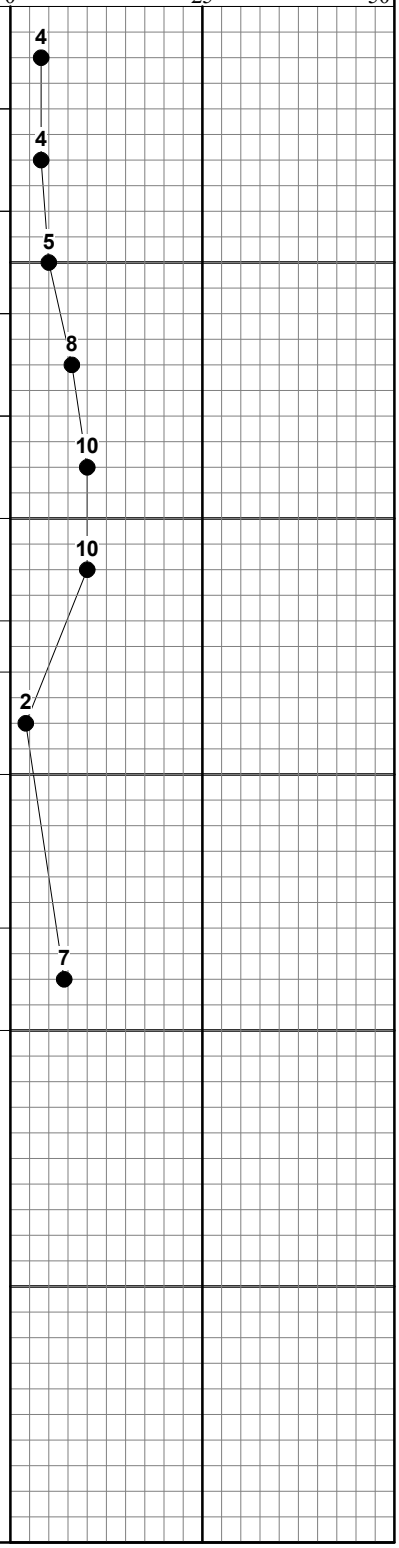
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-3**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/25/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			
					Silty SAND (SM) Very loose, fine to medium, brown			3 2 2 2 2 2 2 2
			1					
		5			**Silty SAND (SM)** Loose, fine to medium, brown, with trace clay			2 2 3 3
			2		**Silty SAND (SM)** Loose, fine to medium, brown and red			3 4 4 5 6 5 5 11
		10	3		**Sandy, High Plasticity CLAY (CH)** Stiff to very soft, brown and orange		PP=1.75 tsf	5 5 5 5
			4				PP=0.75 tsf	2 1 1 1
		15						
			5		**Silty SAND and SHELL (SM-SHELL)** Loose, fine to medium, brown and gray, Yorktown Formation	▽		3 4 3 2
		20	6		Boring terminated at 20 feet.			
			7					
		25						
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



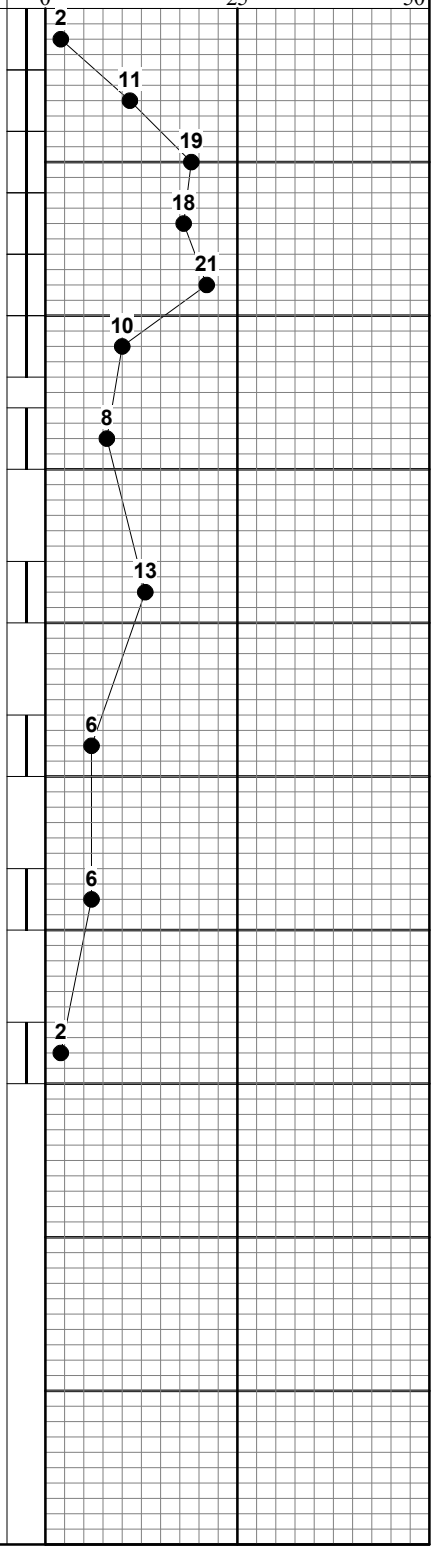
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-4**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/26/2012**
Depth (ft.): **35.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			1 1 1 1
					Clayey SAND (SC) Very loose, fine to medium, orange			4
					Sandy, High Plasticity CLAY (CH) Stiff to very stiff, orange and brown			5 6 8 8 9 10 10 7 9 9 11 10 10 11 12
		5	1					
			2					
		10	3			▽		
					Clayey SAND (SC) Loose, fine to medium, orange and gray			3 4 6 10
			4		**Sandy, High Plasticity CLAY (CH)** Firm, orange and gray			3 4 4 6
		15	5					
					Silty SAND (SM) Firm to loose, fine to medium, orange and brown			5 6 7 7
		20	6					
			7					4 3 3 4
		25	8					
					Silty SAND (SM) Loose, fine to medium, orange and brown, with trace clay			3 3 3 3
		30	9					
					Sandy, Low Plasticity CLAY (CL) Very soft, orange and brown			1 1 1 2
			10				PP=0.5 tsf	
		35			Boring terminated at 35 feet.			
			11					
		40	12					
			13					
		45	14					
			15					

Uncorrected Penetration Resistance (blows/foot)



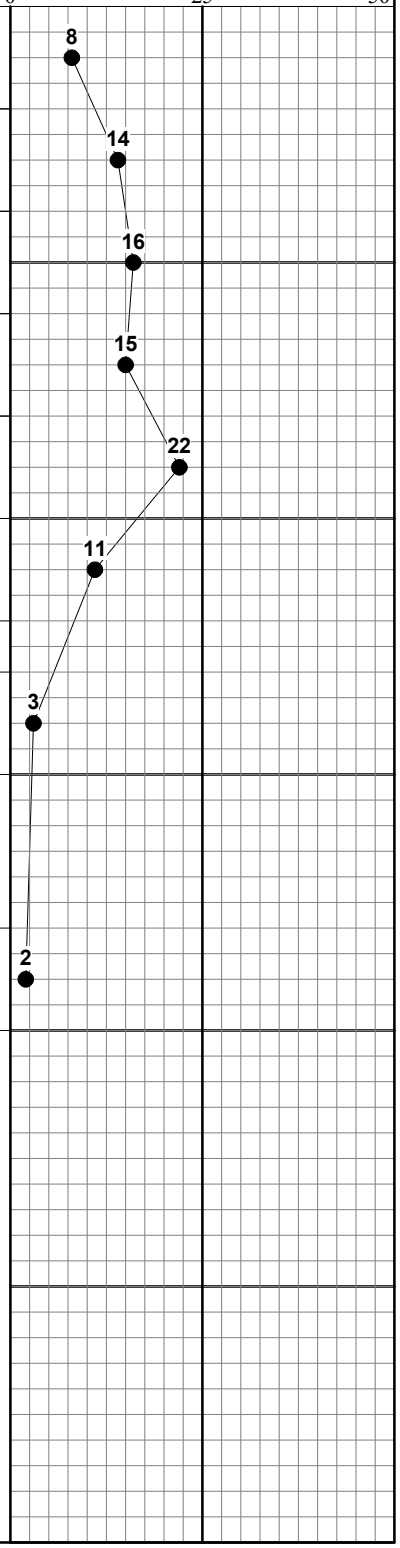
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-5**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/21/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			4
					Silty SAND (SM) Loose, fine to medium, brown			4 4 4
					Sandy, High Plasticity CLAY (CH) Stiff to very stiff, orange and gray		PP=2.5 tsf	5 6 8 8 7 8
		5	1		**Silty SAND (SM)** Firm, fine to medium, gray			8 9 5 8 7 7
					Silty SAND (SM) Firm, fine to coarse, orange, with trace clay			10 11 11 12
		10	3		**Sandy, High Plasticity CLAY (CH)** Stiff to very soft, orange		PP=1.0 tsf	4 4 7 8
			4				PP=0.5 tsf	2 1 2 2
		15	5			▽	PP=0.078 tsf	2 1 1 2
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



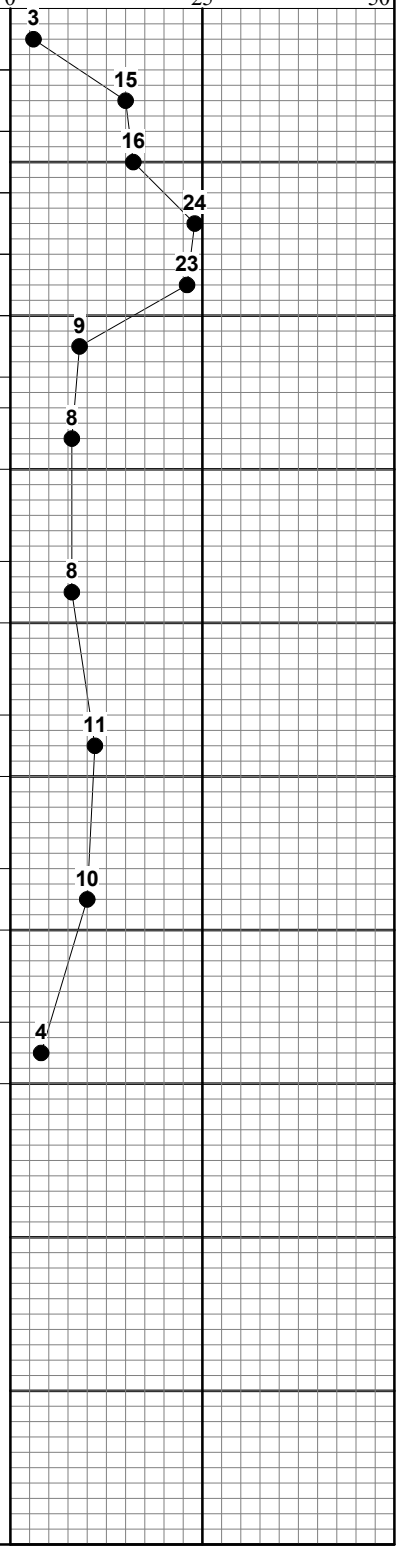
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-6**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/26/2012**
Depth (ft.): **35.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			1 1 2 2
			1		**Clayey SAND (SC)** Very loose, fine to medium, brown and orange			3 7 8 8
		5	2		**Sandy, Low Plasticity CLAY (CL)** Stiff to very stiff, orange, red and brown	▽	PP=2.5 tsf PP=2.5 tsf	10 7 9 8 12 13 11 10
		10	3				PP=3.0 tsf PP=2.5 tsf	13 13 10 11 3 4 5 5
			4		**Clayey SAND (SC)** Loose, fine to medium, brown and orange			4 3 5 6
		15	5					
			6		**Silty SAND (SM)** Loose to firm, fine to medium, orange and red			4 4 4 6
		20	7					7 6 5 7
		25	8					
		30	9					4 4 6 8
			10		**Sandy, Low Plasticity CLAY (CL)** Soft, gray and brown		PP=1.0 tsf	2 2 2 2
		35	11		Boring terminated at 35 feet.			
		40	12					
		45	13					
			14					
			15					

Uncorrected Penetration Resistance (blows/foot)



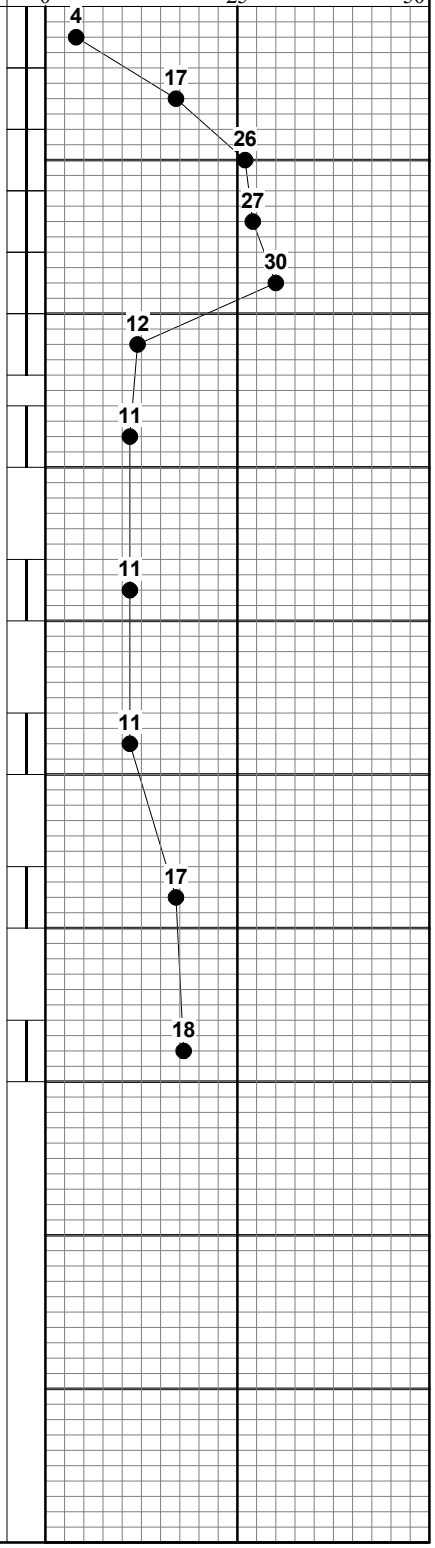
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-7**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/25/2012**
Depth (ft.): **35.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **3" Mud Rotary**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments
					4 inches TOPSOIL		
					Silty SAND (SM) Very loose, fine to medium, brown		
					Sandy, Low Plasticity CLAY (CL) Firm, fine to medium, brown, orange and red	▽	
					Silty, Low Plasticity CLAY (CL) Stiff, orange and gray		PP=3.0 tsf
					Silty SAND (SM) Firm, fine to medium, orange, gray and red		
					Boring terminated at 35 feet.		

SPT Blows: 1 2 2 2 5 7 10 10 15 13 13 12 14 14 13 13 13 14 16 14 4 6 6 7 3 4 7 5 4 4 7 11 4 4 7 8 6 6 11 12 6 7 11 11



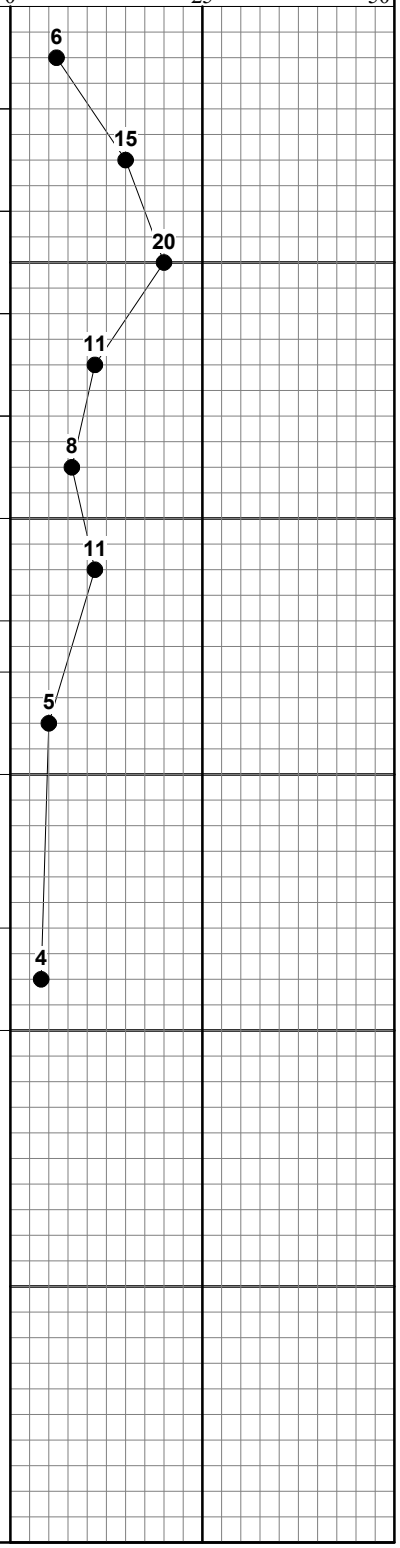
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-8**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/25/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			2
					Low Plasticity Sandy CLAY (CL) Loose to firm, fine to medium, orange and gray			2 4 4 6 7 8 8
		5	1		**Silty SAND (SM)** Firm to loose, fine to medium, orange			12 10 10 10 11 6 5 5 4 4 4 4
		10	2					4 5 6 7
		15	3		**Clayey SAND (SC)** Loose, fine to medium, brown and orange	▽		2 2 3 4
		20	4		**Sandy, Low Plasticity CLAY (CL)** Soft, orange, with trace shell fragments		PP=0.5 tsf	2 2 2 2
		25	5		Boring terminated at 20 feet.			
			6					
			7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



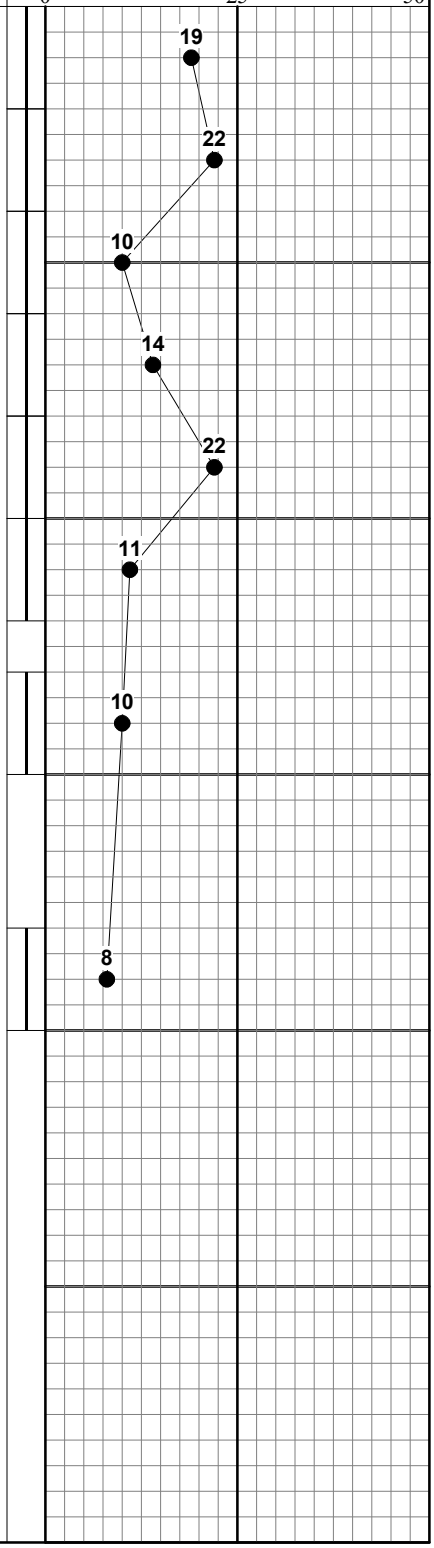
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-9**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/22/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			9
					Silty SAND (SM) Firm, fine to medium, brown			10 9 9
					Sandy, Low Plasticity CLAY (CL) Very stiff to stiff, tan and orange			10 11
			1				PP=1.75 tsf	11 7
		5					PP=3.0 tsf	6 5 5 7
			2				PP=1.5 tsf	6 7 7 5
							PP=1.75 tsf	10 11 11 11
		10	3		**Slighlty Silty SAND (SP-SM)** Firm to loose, fine to medium, orange and gray			5 6 5 5
			4					5 5 5 4
		15	5					4 4 4 4
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)

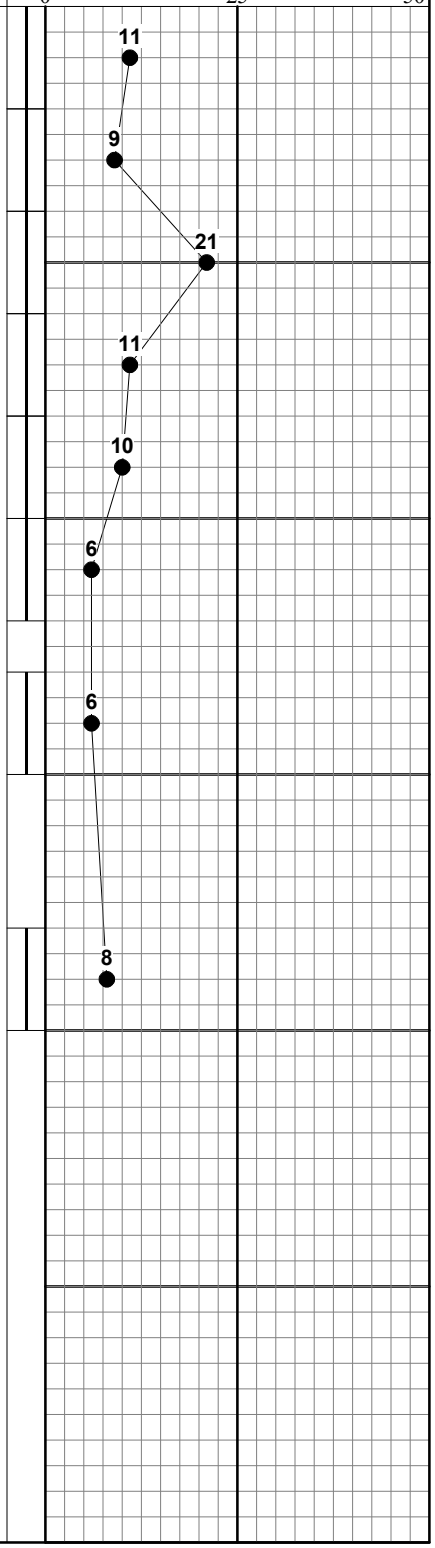


TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-10**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/22/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			6
					Silty SAND (SM) Firm, fine to medium, orange			5 6 8
			1		**Clayey SAND (SC)** Loose, fine to medium, orange			5 4 5 5
		5			**Silty SAND (SM)** Firm, fine to medium, brown			9 11 10 10
			2		**Clayey SAND (SC)** Firm, fine to medium, orange and tan			6 6 5 5
					Slighlty Silty SAND (SP-SM) Loose, fine to medium, tan			5 5 5 6
		10	3		**Silty SAND (SM)** Loose, fine to coarse, orange			2 2 4 3
			4		**Silty SAND (SM)** Loose, fine to coarse, orange and brown			2 2 4 4
		15	5					2 4 4 4
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					



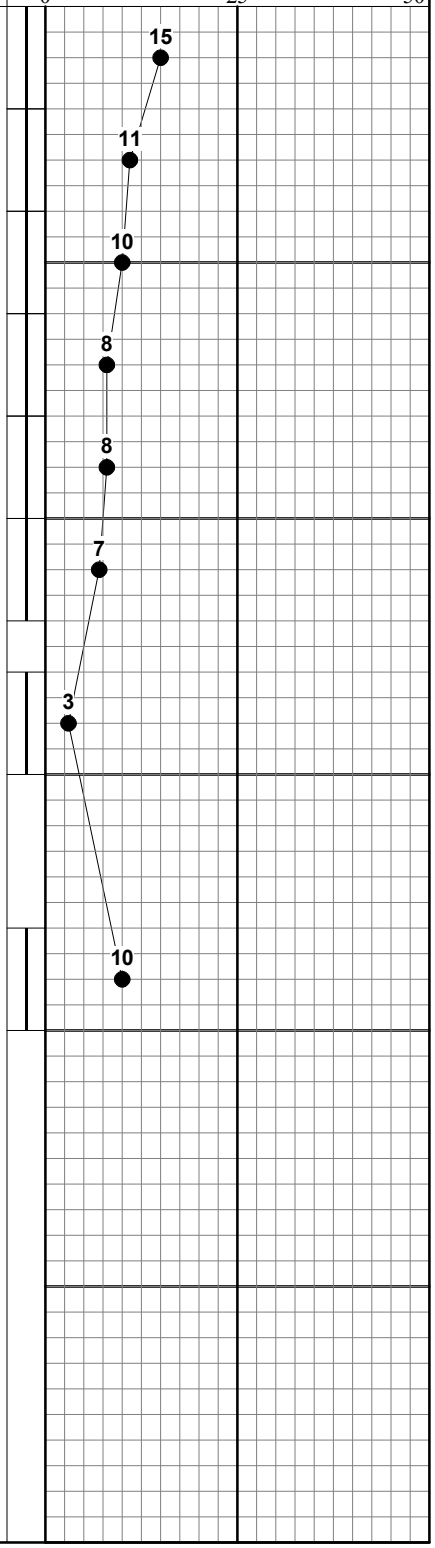
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-11**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/18/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					8 inches ASPHALT			
					Silty SAND (SM) Firm, fine to medium, orange, with trace clay			11, 4, 4
					Sandy, Low Plasticity CLAY (CL) Stiff, orange and gray			3, 5, 6, 5
			1				PP=3.5 tsf	3, 5, 5
		5					PP=2.5 tsf	3, 5, 5
						▽		3, 4, 4, 4
			2		**Silty, Low Plasticity CLAY (CL)** Firm, orange and gray			1, 2, 6, 6
		10	3		**Silty SAND (SM)** Loose to very loose, fine to medium, gray and brown		PP=0.25 tsf	3, 3, 4, 6
			4					1, 2, 1, 2
		15	5					
					Sandy, Low Plasticity CLAY (CL) Firm, orange and gray			3, 3, 7, 5
		20	6		**Clayey SAND (SC)** Loose, fine to medium, orange and gray		PP=2.5 tsf	
					Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



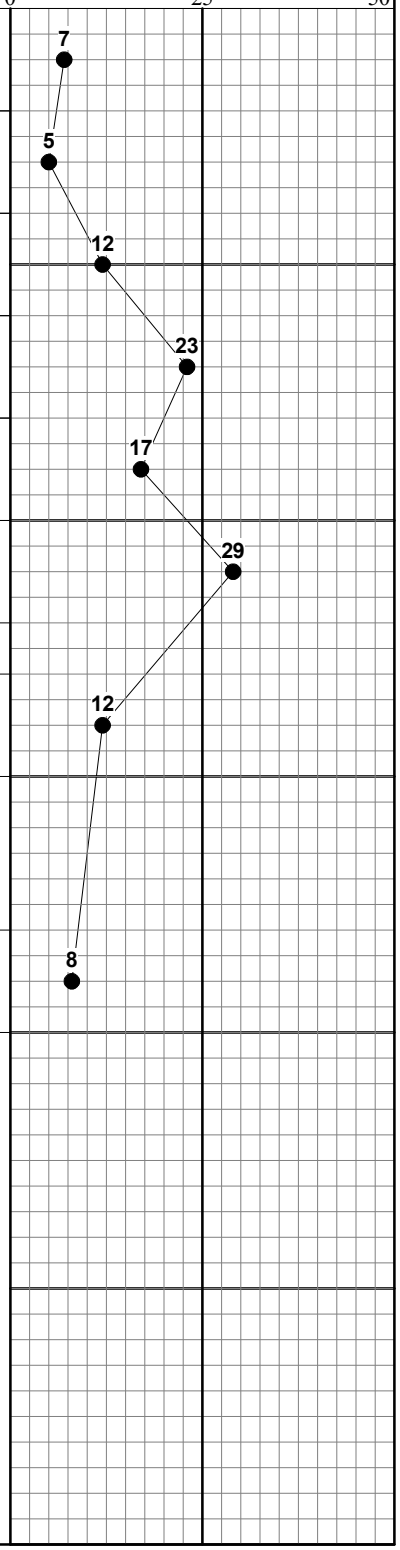
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-12**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/18/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					6 inches ASPHALT Underlain by 6 inches of CRUSHED STONE			3, 4, 3
					Silty SAND (SM) Loose, fine to medium, brown			4, 2, 3, 4
					WOOD Fragments			4, 6, 6, 10
			1		**Silty SAND (SM)** Loose, fine to medium, brown	▽		7, 10, 13, 15
		5			**Sandy, Low Plasticity CLAY (CL)** Firm to stiff, brown, orange and red			7, 7, 10, 9
			2		**Silty SAND (SM)** Firm, fine to medium, orange and red, with trace clay			10, 14, 15, 14
		10	3		**Silty SAND (SM)** Firm, fine to medium, orange, with trace clay			3, 4, 8, 11
			4		**Sandy, Low Plasticity SILT (ML)** Stiff, orange		PP=0.188 tsf	4, 4, 4, 4
		15	5		**Clayey, Low Plasticity SILT (ML)** Firm, orange and black		PP=0.125 tsf	
		20	6		Boring terminated at 20 feet.			
		25	7, 8, 9					

Uncorrected Penetration Resistance (blows/foot)



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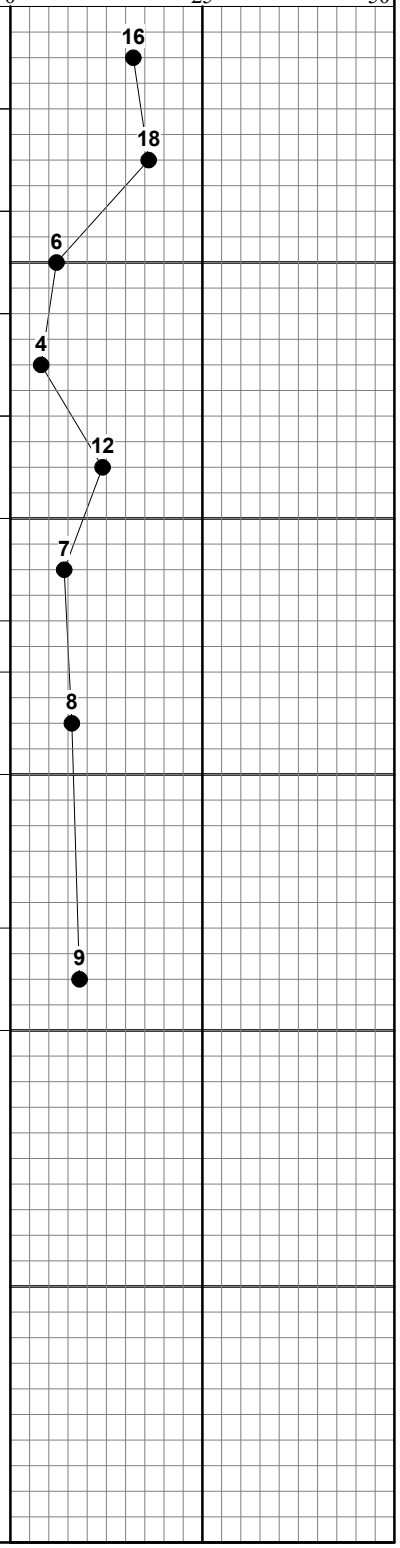
TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-13**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/21/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					8 inches TOPSOIL			5
					Silty SAND (SM) Firm, fine to medium, brown, with trace gravel and trace clay			8 8 9
					Silty SAND (SM) Firm to loose, fine to medium, brown			5 9 9 10
		5	1					2 3 3 4
			2		**Slightly Silty SAND (SP-SM)** Very loose, fine to medium, brown, with trace clay			2 2 2 2
					Sandy, Low Plasticity CLAY (CL) Stiff to firm, orange and gray		PP=2.5 tsf	5 5 7 7
		10	3				PP=1.25 tsf	2 2 5 7
			4				PP=2.0 tsf	2 3 5 9
		15	5					
					Slightly Silty SAND (SP-SM) Loose, fine to medium, gray and tan			3 4 5 5
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



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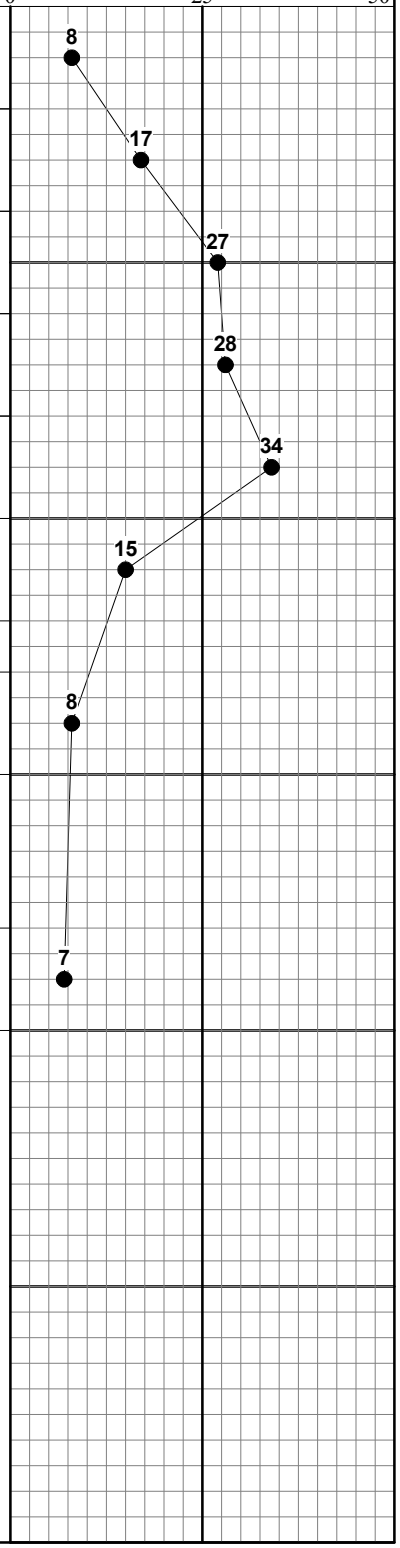
TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-14**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/21/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					8 inches TOPSOIL			3
					Silty SAND (SM) Firm to very stiff, tan and orange and red			4 4 5 5 7 10 9
			1					
					Sandy, Low Plasticity CLAY (CL) Very stiff, orange and gray		PP=3.0 tsf	14 12 15 12 13 15 13 13
		5						
			2					
					Clayey SAND (SC) Dense, fine to medium, orange, gray and red			14 17 17 13
		10	3					
					Sandy, Low Plasticity CLAY (CL) Stiff, orange, gray and red		PP=4.5 tsf	4 7 8 8
					Slightly Silty SAND (SP-SM) Loose, fine to medium, gray and orange			3 4 4 5
			4					
		15						
			5					
					Slightly Silty SAND (SP-SM) Loose, fine to medium, gray			2 3 4 4
			6					
		20			Boring terminated at 20 feet.			
			7					
		25						
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



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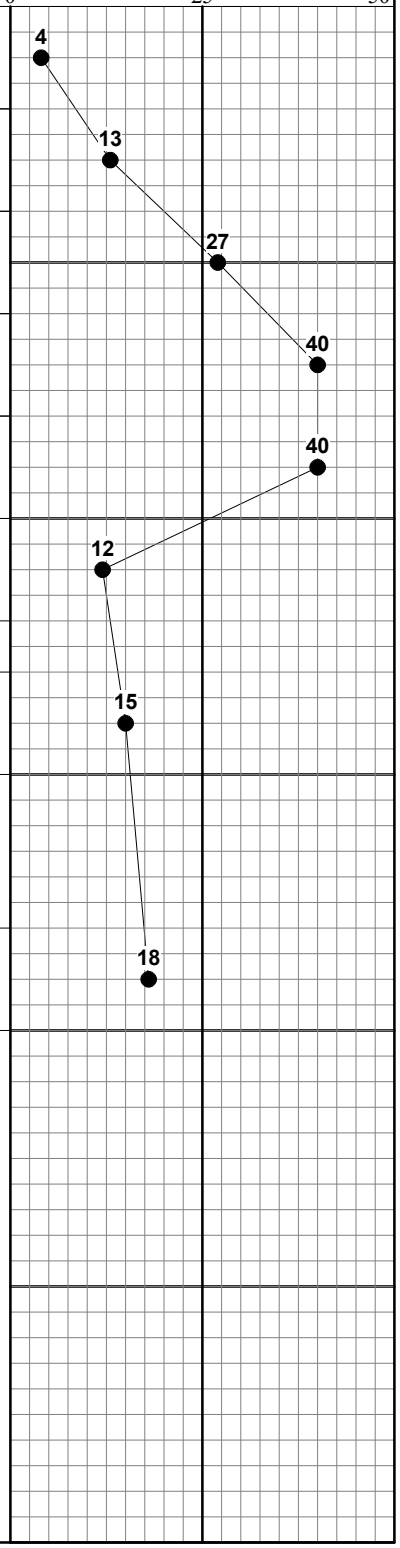
TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-15**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/21/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					8 inches TOPSOIL			2
					Sandy, Low Plasticity CLAY (CL) Soft to hard, tan and orange			2, 2, 2, 5, 6, 7, 8, 11, 12, 15, 16, 22, 22, 18, 19, 24, 20, 20, 22
		10	3		**Sandy, Low Plasticity CLAY (CL)** Stiff, orange and red		PP=4.0 tsf	3, 5, 7, 13
					Silty SAND (SM) Firm, fine to medium, tan and orange			5, 7, 8, 9
					Slightly Silty SAND (SP-SM) Firm, fine to medium, orange and tan			4, 9, 9, 9
		20	6		Boring terminated at 20 feet.			

Uncorrected Penetration Resistance (blows/foot)



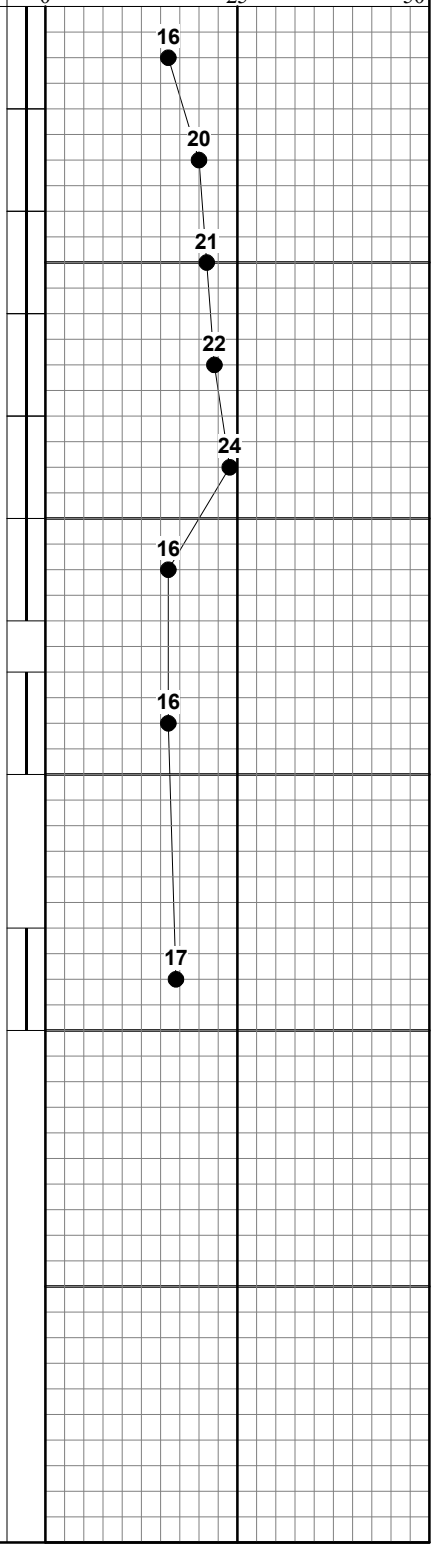
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-16**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/20/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			5
					Sandy, Low Plasticity CLAY (CL) Very stiff, orange and red			6, 10, 10, 10, 10, 10, 11, 9, 10
		5	1		**Silty SAND (SM)** Firm, fine to medium, orange and red, with trace clay			11, 11, 10
			2		**Clayey SAND (SC)** Firm, fine to medium, orange, red and gray			11, 11, 13, 9, 12, 12, 13, 7, 8, 8, 9, 9, 8, 8, 8, 10, 9, 8, 7
		10	3					
			4					
		15	5					
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



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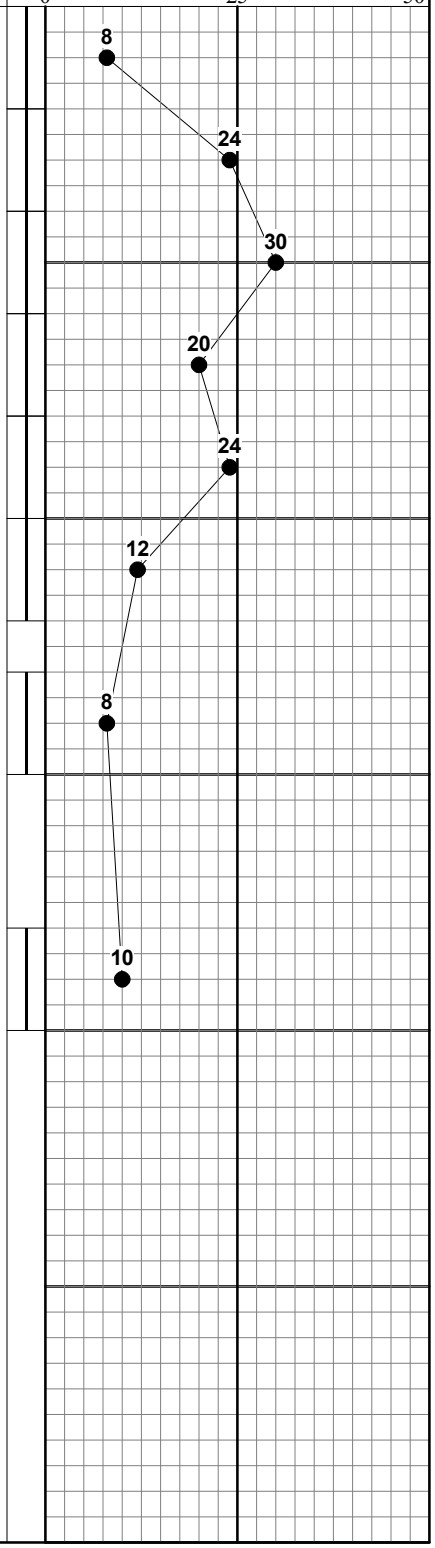
TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-17**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/20/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					4 inches TOPSOIL			3
					Sandy, Low Plasticity CLAY (CL) Firm, orange		PP=3.0 tsf	3 5 7
			1		**Clayey SAND (SC)** Firm, fine to medium, orange			9 11 13 12
		5	2		**Sandy, High Plasticity CLAY (CH)** Dense to very stiff, orange		PP=4.0 tsf PP=3.0 tsf	13 16 14 15 6 9 11 12
					Clayey SAND (SC) Dense, fine to medium, orange, gray and red			15 12
		10	3		**Silty SAND (SM)** Firm, fine to medium, orange			12 13 3 6 6 7
			4		**Sandy, Low Plasticity CLAY (CL)** Firm, gray and red		PP=1.5 tsf	2 3 5 4
		15	5					
			6		**Slightly Silty SAND (SP-SM)** Loose, fine to medium, orange			2 5 5 7
		20			Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



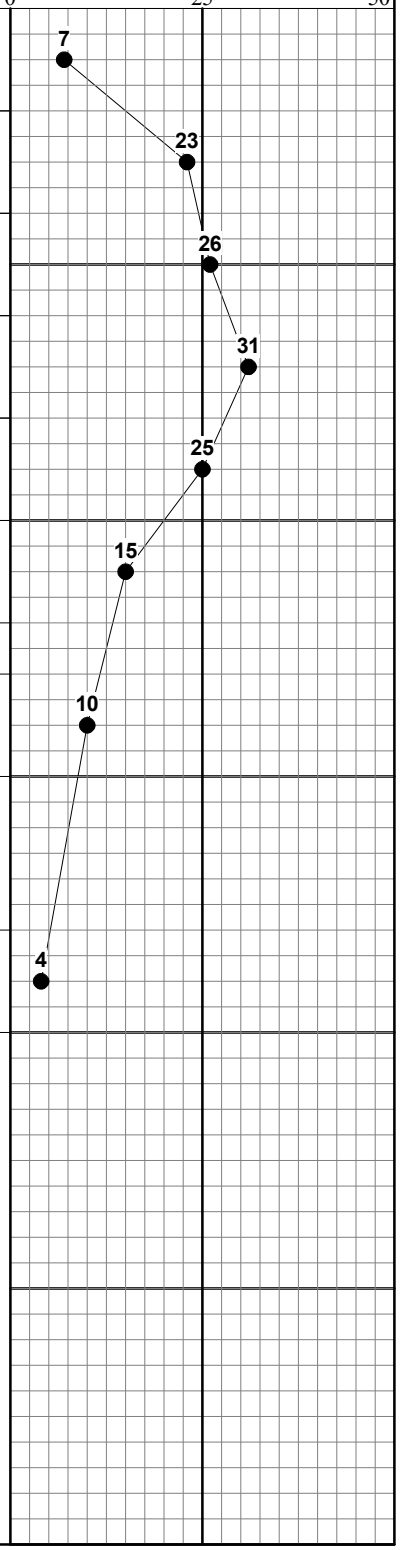
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-18**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/20/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			2
					Sandy, Low Plasticity CLAY (CL) Firm, orange, red and gray			2 5 6 8 11
			1		**Silty SAND (SM)** Firm to dense, fine to medium, orange			12 12 16 13 13 11
		5	2			▽		14 15 16 15 16 12 13 13
		10	3		**Slightly Silty SAND (SP-SM)** Firm to loose, fine to medium, orange and red			3 7 8 8 3 5 5 5
		15	4					
			5		**Clayey, Low Plasticity SILT (ML)** Soft, orange and red		PP=0.219 tsf	2 2 2 2
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



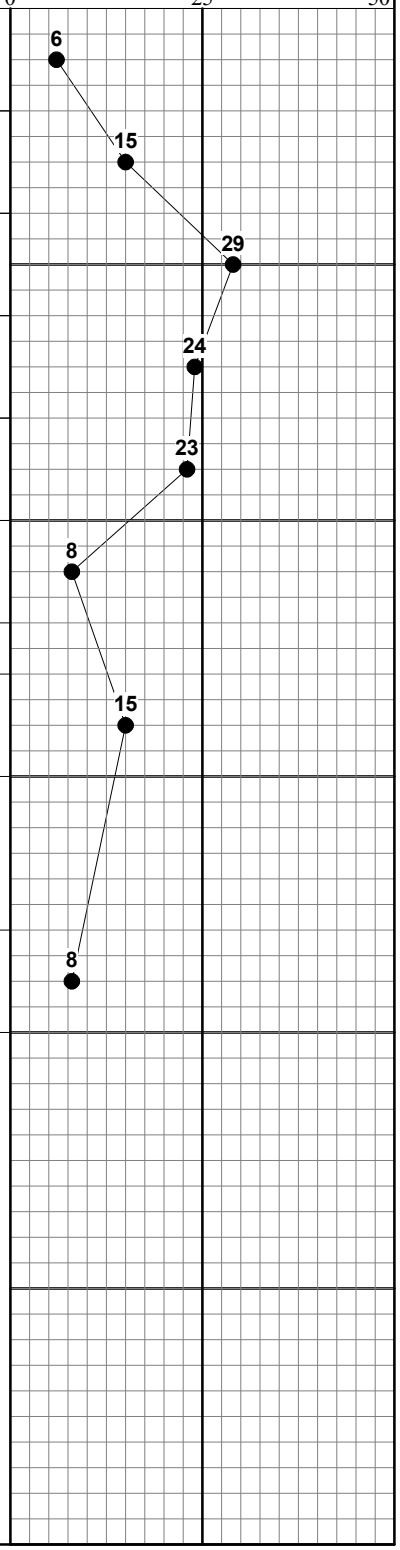
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-19**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/20/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					3 inches TOPSOIL			2
					Silty SAND (SM) Loose, fine to medium, brown			2 4 2
					Sandy, High Plasticity CLAY (CH) Firm, orange, red and gray			7 7
			1				PP=4.0 tsf	8 9
		5						15 14
							PP=4.0 tsf	15 11
			2			▽		13 12
							PP=2.5 tsf	12 12
								10 11
							PP=1.0 tsf	12 12
		10	3					3 4
							PP=1.0 tsf	4 4
			4					5 7
							PP=1.0 tsf	8 10
		15	5					
					Silty SAND (SM) Loose to firm, fine to medium, orange, with trace clay			3 3 5 5
		20	6		Boring terminated at 20 feet.			
		25	7					
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



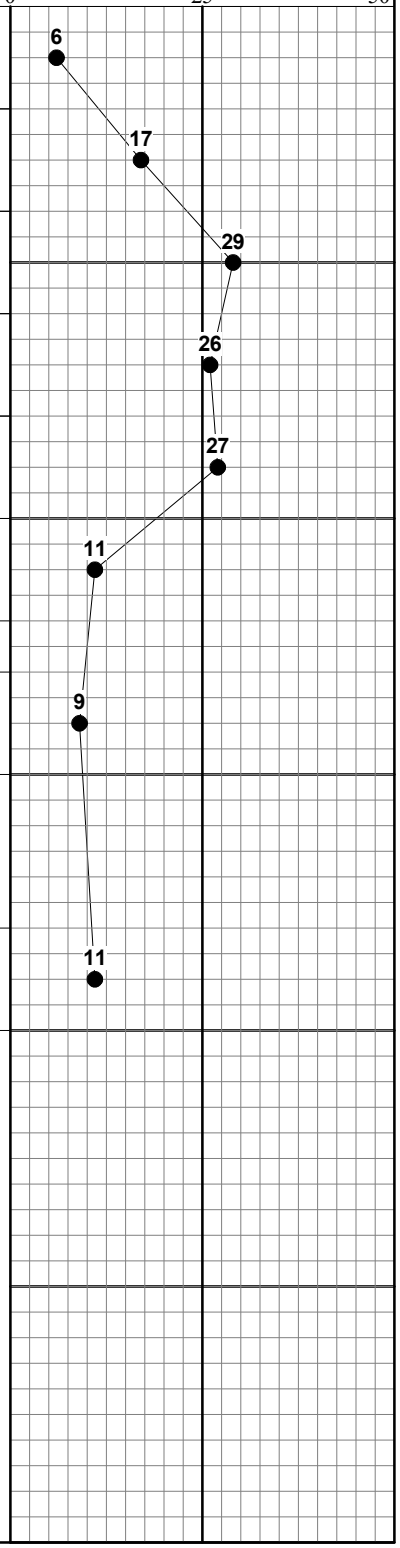
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-20**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/20/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					2 inches TOPSOIL			5
					6 inches CRUSHED STONE			3
					Sandy, Low Plasticity CLAY (CL) Firm to very stiff, orange and gray		PP=1.25 tsf	3
								3
								5
								8
			1				PP=4.0 tsf	9
						▽		9
								15
								17
		5					PP=4.0 tsf	12
								12
			2					19
								12
							PP=3.0 tsf	14
								12
								18
								15
							PP=1.25 tsf	12
								12
		10	3		**Silty SAND (SM)** Firm, fine to medium, orange			6
								5
								6
								6
					Clayey SAND (SC) Loose, fine to medium, orange, gray and red			
			4					5
								5
								4
		15						3
			5					
					Silty SAND (SM) Firm, fine to medium, orange and gray			
								5
								5
								6
		20	6		Boring terminated at 20 feet.			7
			7					
		25						
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



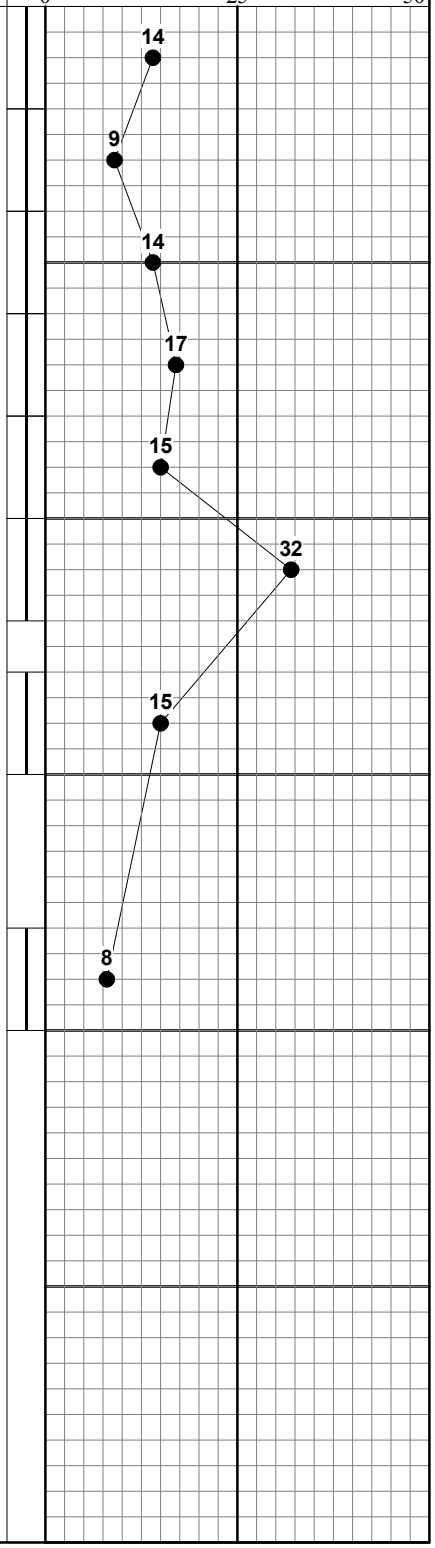
TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

TEST BORING RECORD

GeoEnvironmental Resources, Inc. Environmental, Groundwater, Hazardous Materials, Geotechnical & Industrial Engineering Consultants		Boring No. **P-21**
Project: **P984-P989 MCSFRC Phase 1**	GER Project Number: **110-5960**	Sheet No. **1** of **1**
Location: **NWS Yorktown**	Driller: **Fishburne**	Date Drilled: **6/21/2012**
Depth (ft.): **20.0** / Elevation (ft.):	Client: **NAVFAC Midlant**	Drill Method: **2-1/4" H.S.A.**

Elevation ft	Elevation m	Depth ft	Depth m	Lithology	Material Description	Ground Water	Comments	SPT
					5 inches TOPSOIL			2
					Silty SAND (SM) Firm to loose, fine to medium, brown			6 8 3 4 4
			1		**Sandy, High Plasticity CLAY (CH)** Stiff to very stiff, orange and red		PP=3.0 tsf	5 5 5 6
		5					PP=4.5 tsf	8 8 8 8
			2				PP=2.0 tsf	9 5 9 6
							PP=2.0 tsf	9 7
		10	3		**Sandy, Low Plasticity CLAY (CL)** Hard, orange		PP=2.0 tsf	8 17 15 13
					Clayey SAND (SC) Firm, fine to medium, orange and red			2 5 10 10
		15	4					
			5		**Silty SAND (SM)** Loose, fine to medium, orange and red, with trace clay			2 3 5 7
		20	6		Boring terminated at 20 feet.			
			7					
		25						
			8					
			9					

Uncorrected Penetration Resistance (blows/foot)



TEST BORING RECORD WITH SPT & GRAPH 5960.GPJ GEOENVIRONMENTAL RESOURCES.GDT 7/16/12

DMT SOUNDING DATA

References: Schmertmann, J. H., "**Suggested ASTM Method for Performing the Flat Dilatometer Test**," *Geotechnical Testing Journal*, GTJODJ, Vol. 9, No. 2, June 1986, pp. 93-101.

Marchetti, S., et al, "**The Flat Dilatometer Test (DMT) in Soil Investigations**," *Report of the ISSMGE Technical Committee 16 on Ground Property Characterization from In-situ Testing*, IN-SITU 2001, May 2001.

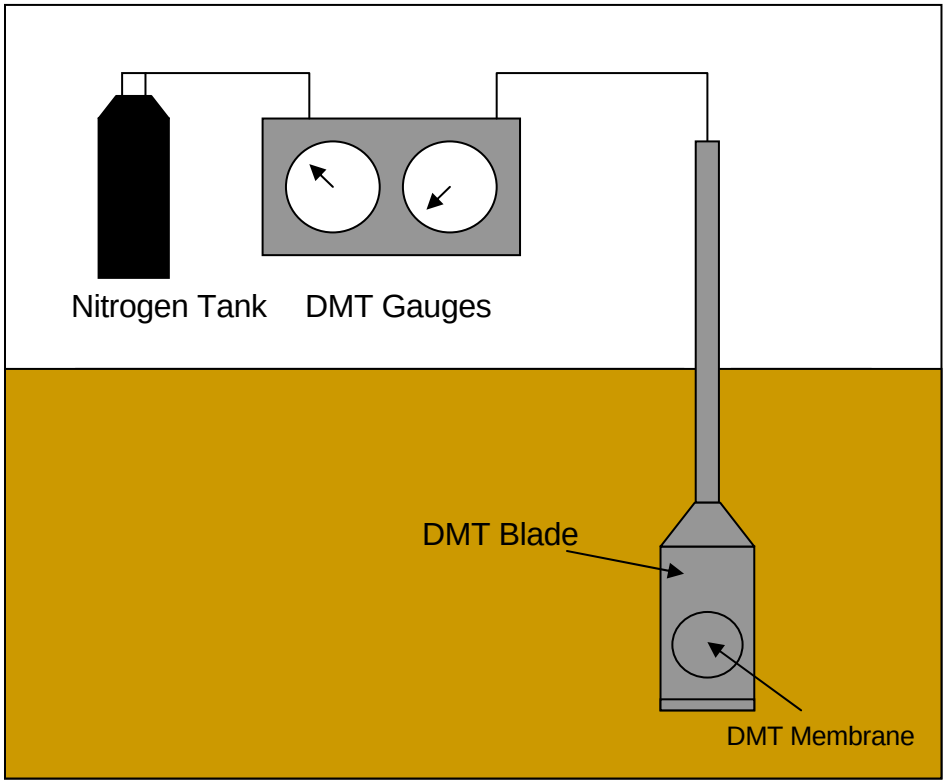
Riaund, J. L. And Miran, J., "**The Flat Dilatometer Test**," *Publication No. FHWA-SA-91-044*, Final Report, U.S. Department of Transportation, Federal Highway Administration, February 1992.

Contractor: ConeTec, Inc.

The enclosed testing records represent an interpretation of the subsurface conditions encountered at the specific testing locations at the time explorations were made. It is possible that subsurface conditions between testing locations will be different from those indicated. Surface and strata elevations, if shown, shall be considered approximate and are referenced to project datum shown on the plans or described in the geotechnical report unless noted otherwise.

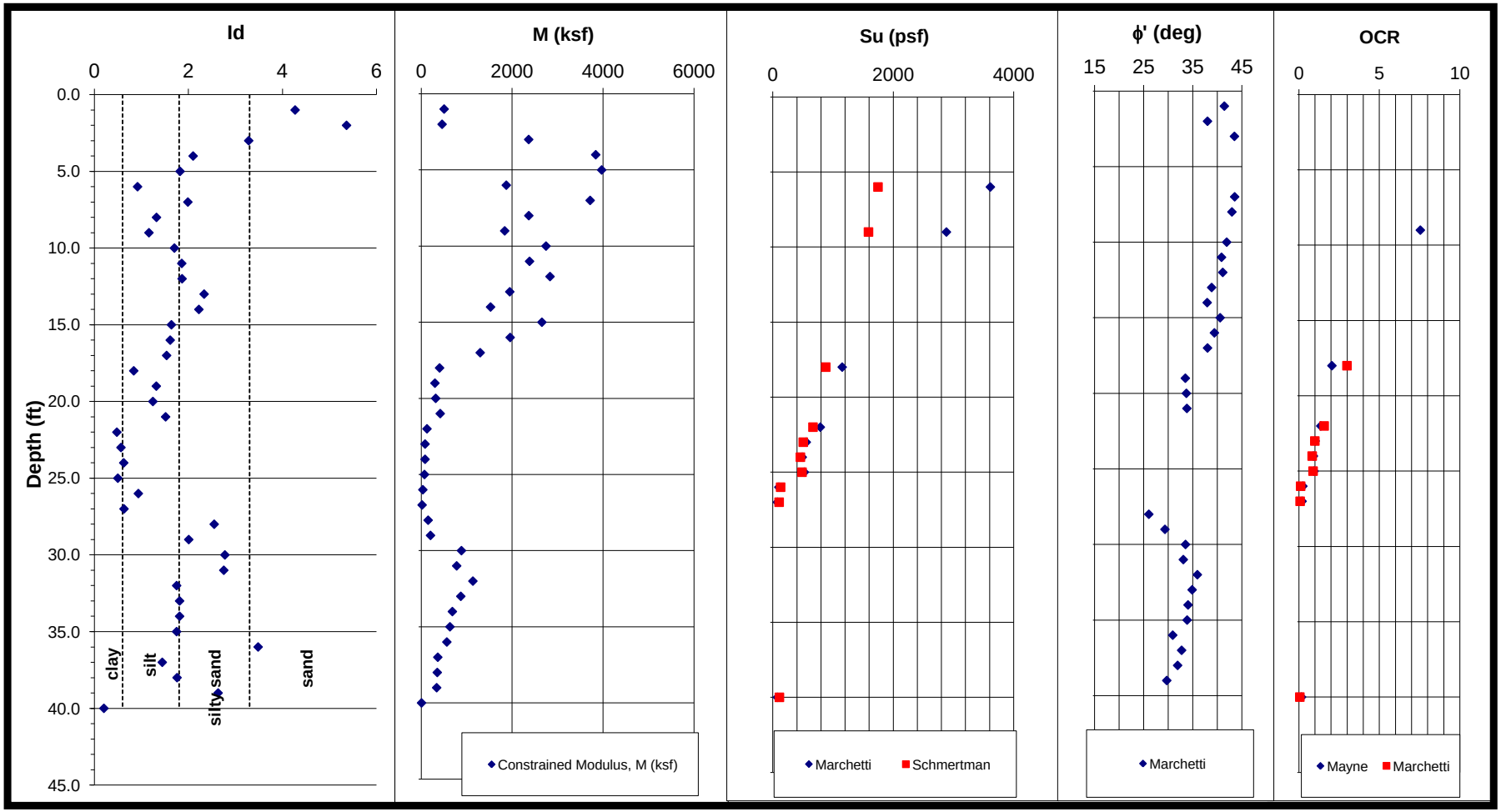
Dilatometer Procedures

The dilatometer testing was performed in accordance with ASTM D 6635-01. Eight dilatometer soundings were performed at select locations. At approximately 1 foot intervals, the penetration was halted and the A, and B pressure measurements were taken. The A pressure measurement is defined as the amount of pressure applied to inflate the membrane to be flush with the plane of the dilatometer blade. The B pressure measurement is defined as the amount of pressure applied to inflate the membrane to extend 1.1 mm beyond the plane of the dilatometer blade.



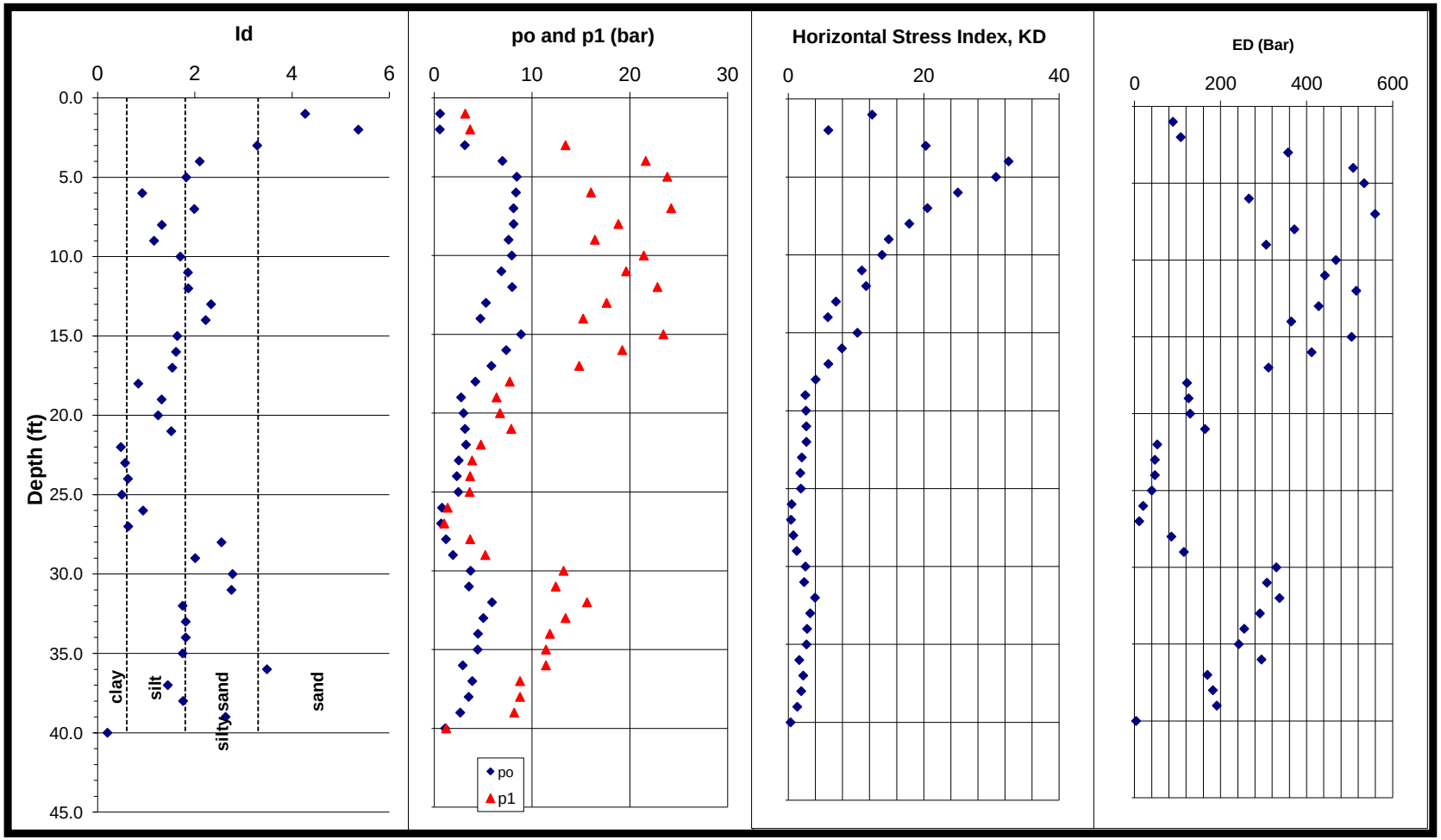
DILATOMETER TEST RESULTS

Test ID: DMT-1
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



DILATOMETER TEST RESULTS

Test ID: DMT-1
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



Job No: 12-951
Job Name: MCSFRC Yorktown
Job Location: Yorktown, VA
Date: 6/26/12
Sounding No: DMT-1
Ground Water Depth (ft): 20

	Membrane 1	Membrane 2	Membrane 3	
ΔA =	0.225	0	0	bar
ΔB =	0.175	0	0	bar
Zm=	0 bar			

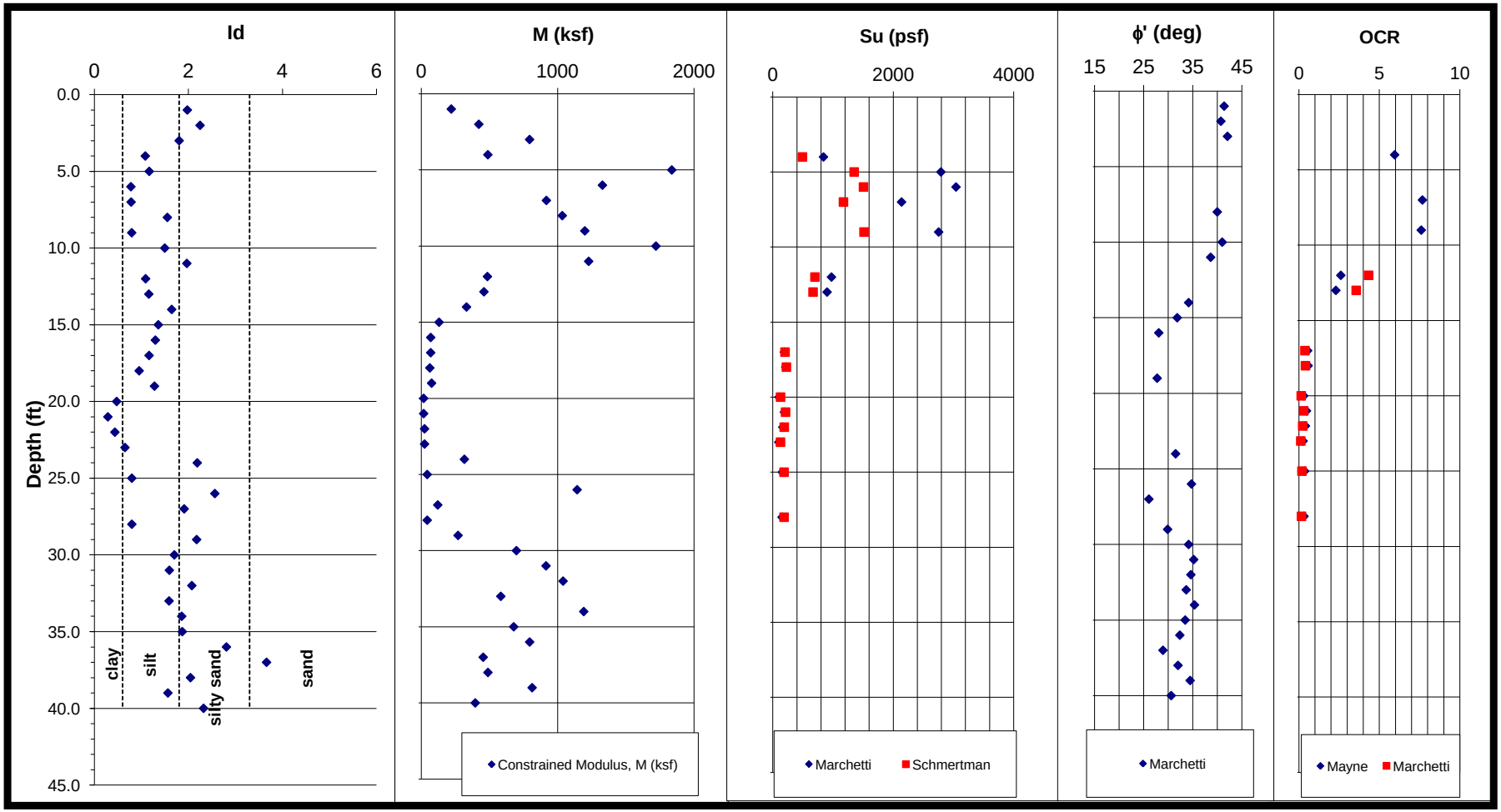
[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

CONETEC

Depth[1] (ft)	A (bar)	B (bar)	C (bar)	po (bar)	p1 (bar)	p2 (bar)	u_o (psf)	σ_{vo} (psf)	σ_{vo}' (psf)	Id	K_D	E_D (bar)	K_o	OCR[2]	OCR[3]	ϕ'[4] (deg)	R_M	E_D (ksf)	s_u[6] (psf)	s_u[7] (psf)	M (ksf)
1.0	0.5	3.35		0.6	3.175		0	102	102	4.27	12.4	89				41.4	2.70	186			504
2.0	0.5	3.85		0.6	3.675		0	204	204	5.36	5.9	107				38.0	2.04	224			459
3.0	3.4	13.6		3.1	13.425		0	323	323	3.28	20.3	357				43.5	3.17	746			2364
4.0	7.45	21.8	0	7.0	21.625		0	448	448	2.10	32.5	508				45.3	3.62	1062			3839
5.0	8.95	24		8.4	23.825		0	575	575	1.82	30.7	534				45.1	3.56	1115			3970
6.0	8.5	16.2		8.4	16.025		0	697	697	0.92	25.0	266	3.2	12.7	51.5		3.37	556	3613	1746	1871
7.0	8.65	24.4		8.1	24.225		0	824	824	1.99	20.5	559				43.5	3.18	1168			3716
8.0	8.4	19	0	8.1	18.825		0	949	949	1.32	17.9	372				43.0	3.05	776			2367
9.0	7.8	16.6		7.6	16.425		0	1072	1072	1.16	14.8	306	2.3	7.5	22.8		2.87	639	2883	1588	1836
10.0	8.35	21.6		7.9	21.425		0	1197	1197	1.70	13.8	468				41.9	2.81	978			2745
11.0	7.25	19.8		6.9	19.625		0	1322	1322	1.86	10.9	443				40.9	2.58	925			2383
12.0	8.45	23	0	8.0	22.825		0	1448	1448	1.86	11.5	516				41.1	2.63	1077			2834
13.0	5.65	17.8		5.3	17.625		0	1571	1571	2.33	7.0	428				38.9	2.18	894			1948
14.0	5	15.4		4.7	15.225		0	1692	1692	2.22	5.8	364				38.0	2.00	761			1525
15.0	9.35	23.6		8.9	23.425		0	1819	1819	1.64	10.2	505				40.6	2.52	1054			2655
16.0	7.7	19.4	0	7.4	19.225		0	1943	1943	1.61	7.9	412				39.4	2.28	860			1957
17.0	6.05	15		5.8	14.825		0	2064	2064	1.54	5.9	312				38.0	1.99	651			1297
18.0	4.15	7.9		4.2	7.725		0	2178	2178	0.84	4.0	122	1.0	2.1	3.0		1.58	255	1152	879	404
19.0	2.7	6.55		2.8	6.375		0	2290	2290	1.32	2.5	126				33.5	1.15	263			301
20.0	2.95	6.9	0	3.0	6.725		0	2402	2402	1.24	2.6	129				33.7	1.18	270			318
21.0	3.15	8.05		3.2	7.875		62	2516	2454	1.51	2.7	164				33.8	1.22	342			418
22.0	3.1	4.95		3.3	4.775		125	2624	2499	0.48	2.7	53	0.7	1.4	1.6		1.15	110	788	667	126
23.0	2.35	4.05		2.5	3.875		187	2729	2542	0.56	2.0	47	0.5	1.0	1.0		0.85	99	555	506	84
24.0	2.15	3.85	0.4	2.3	3.675	0.63	250	2834	2585	0.62	1.8	47	0.5	0.9	0.8		0.85	99	488	457	84
25.0	2.3	3.8		2.5	3.625		312	2939	2627	0.50	1.8	40	0.5	0.9	0.9		0.85	84	522	485	71
26.0	0.6	1.55		0.8	1.375		374	3033	2659	0.93	0.5	20	0.0	0.2	0.1		0.85	42	100	129	36
27.0	0.5	1.2		0.7	1.025		437	3124	2687	0.63	0.4	11	-0.1	0.2	0.1		0.85	23	76	105	19
28.0	1.1	3.85	0	1.2	3.675		499	3228	2729	2.55	0.7	86				26.1	0.85	179			152
29.0	1.85	5.4		1.9	5.225		562	3336	2775	2.01	1.2	115				29.3	0.85	240			204
30.0	3.95	13.4		3.7	13.225		624	3455	2831	2.78	2.5	330				33.5	1.28	689			885
31.0	3.75	12.6		3.6	12.425		686	3573	2886	2.75	2.3	308				33.1	1.21	643			780
32.0	6.15	15.8	0	5.9	15.625		749	3694	2945	1.75	3.9	337				35.9	1.61	704			1137
33.0	5.2	13.6		5.0	13.425		811	3814	3002	1.81	3.2	291				34.9	1.43	609			870
34.0	4.6	12		4.5	11.825		874	3931	3058	1.81	2.8	255				34.1	1.29	533			685
35.0	4.55	11.6		4.4	11.425		936	4049	3113	1.75	2.7	242				33.9	1.25	506			632
36.0	3.1	11.6	0	2.9	11.425		998	4165	3166	3.48	1.6	295				30.9	0.91	616			563
37.0	3.9	8.95		3.9	8.775		1061	4279	3218	1.44	2.2	169				32.7	1.03	354			364
38.0	3.55	8.95		3.5	8.775		1123	4393	3270	1.76	1.9	182				31.9	0.93	380			353
39.0	2.7	8.35		2.7	8.175		1186	4506	3320	2.63	1.3	191				29.7	0.85	400			340
40.0	0.9	1.4	0	1.1	1.225		1248	4592	3344	0.20	0.3	4	-0.1	0.2	0.1		0.85	8	76	109	6

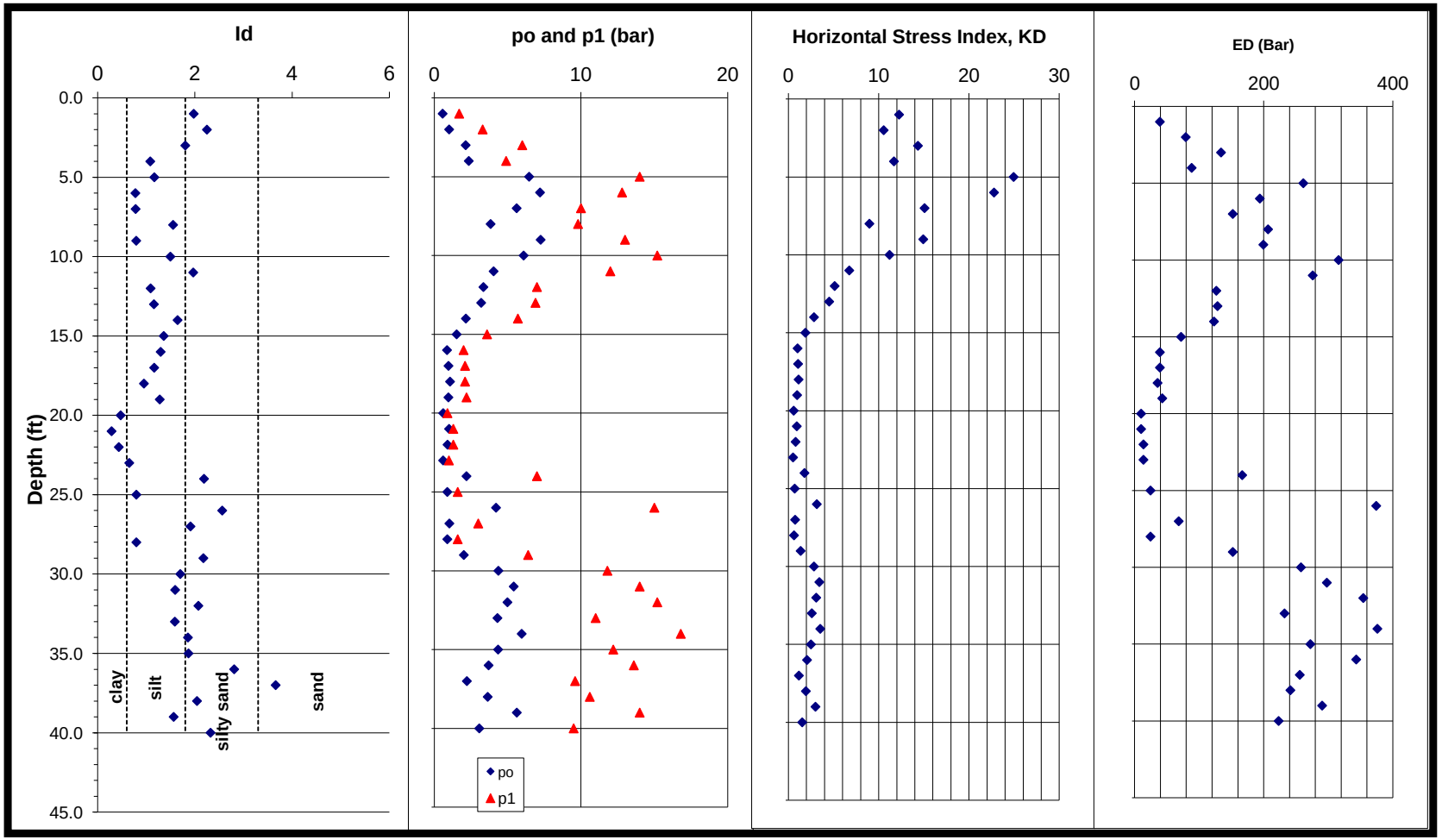
DILATOMETER TEST RESULTS

Test ID: DMT-2
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



DILATOMETER TEST RESULTS

Test ID: DMT-2
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



Job No: 12-951
Job Name: MCSFRC Yorktown
Job Location: Yorktown, VA
Date: 6/27/12
Sounding No: DMT-2
Ground Water Depth (ft): 30

	Membrane 1	Membrane 2	Membrane 3	
ΔA =	0.225	0	0	bar
ΔB =	0.2	0	0	bar
Zm=	0 bar			

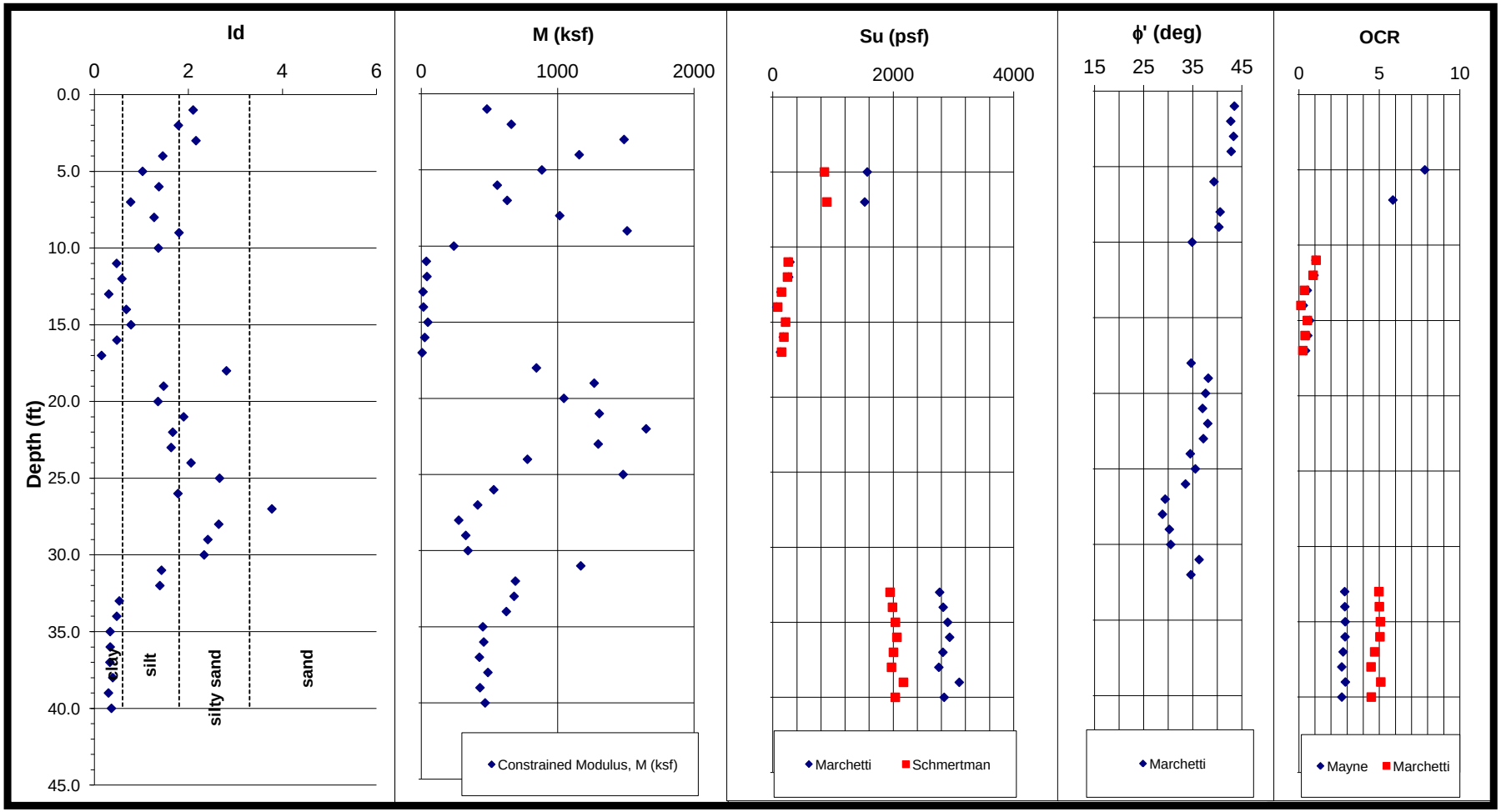
[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

CONETEC

Depth[1] (ft)	A (bar)	B (bar)	C (bar)	po (bar)	p1 (bar)	p2 (bar)	u_o (psf)	σ_{vo} (psf)	σ_{vo}' (psf)	Id	K_D	E_D (bar)	K_o	OCR[2]	OCR[3]	ϕ'[4] (deg)	R_M	E_D (ksf)	s_u[6] (psf)	s_u[7] (psf)	M (ksf)
1.0	0.4	1.9		0.6	1.7		0	97	97	1.98	12.3	39				41.4	2.69	82			220
2.0	0.9	3.5		1.0	3.3		0	201	201	2.25	10.6	79				40.7	2.55	166			422
3.0	2.1	6.2		2.1	6		0	312	312	1.80	14.3	134				42.1	2.84	280			795
4.0	2.25	5.1	0	2.4	4.9		0	421	421	1.08	11.7	88	2.0	5.9	15.7		2.65	185	841	492	489
5.0	6.6	14.2		6.5	14		0	541	541	1.17	24.9	261	3.1	12.7	51.2		3.37	546	2792	1351	1837
6.0	7.25	13		7.2	12.8		0	661	661	0.78	22.8	194	3.0	11.6	44.5		3.28	405	3042	1506	1329
7.0	5.6	10.2		5.6	10		0	778	778	0.78	15.1	152	2.4	7.7	23.4		2.89	318	2138	1173	918
8.0	3.9	10	0	3.8	9.8		0	894	894	1.55	9.0	207				40.0	2.40	432			1034
9.0	7.3	13.2		7.3	13		0	1014	1014	0.79	14.9	199	2.3	7.6	23.0		2.88	417	2754	1514	1200
10.0	6.3	15.4		6.1	15.2		0	1136	1136	1.50	11.2	316				41.0	2.61	660			1721
11.0	4.2	12.2		4.0	12		0	1254	1254	1.97	6.7	276				38.7	2.13	576			1228
12.0	3.3	7.2	0	3.4	7		0	1367	1367	1.09	5.1	127	1.2	2.6	4.3		1.84	264	974	700	485
13.0	3.15	7.1		3.2	6.9		0	1480	1480	1.16	4.5	128	1.1	2.3	3.6		1.71	268	901	668	460
14.0	2.1	5.9		2.2	5.7		0	1590	1590	1.64	2.8	123				34.2	1.29	257			332
15.0	1.4	3.8		1.5	3.6		0	1695	1695	1.36	1.9	72				31.8	0.87	150			131
16.0	0.7	2.2	0	0.9	2		0	1795	1795	1.30	1.0	39				28.1	0.85	82			70
17.0	0.8	2.3		1.0	2.1		0	1895	1895	1.16	1.1	39	0.3	0.5	0.4		0.85	82	191	203	70
18.0	0.9	2.3		1.1	2.1		0	1995	1995	0.95	1.1	36	0.3	0.6	0.4		0.85	74	214	225	63
19.0	0.8	2.4		1.0	2.2		0	2095	2095	1.28	1.0	43				27.8	0.85	89			76
20.0	0.4	1.1	0	0.6	0.9		0	2186	2186	0.47	0.6	10	0.0	0.3	0.1		0.85	21	103	128	18
21.0	0.8	1.5		1.0	1.3		0	2280	2280	0.29	0.9	10	0.2	0.5	0.3		0.85	21	192	211	18
22.0	0.7	1.5		0.9	1.3		0	2374	2374	0.43	0.8	14	0.1	0.4	0.2		0.85	29	165	189	24
23.0	0.4	1.2		0.6	1		0	2467	2467	0.65	0.5	14	0.0	0.3	0.1		0.85	29	99	127	24
24.0	2.2	7.2	0	2.2	7		0	2579	2579	2.19	1.8	167				31.5	0.91	348			316
25.0	0.7	1.8		0.9	1.6		0	2676	2676	0.80	0.7	25	0.1	0.4	0.2		0.85	51	157	186	44
26.0	4.5	15.2		4.2	15		0	2797	2797	2.56	3.1	374				34.7	1.46	782			1143
27.0	0.9	3.2		1.0	3		0	2900	2900	1.91	0.7	68				26.1	0.85	143			121
28.0	0.7	1.8	0	0.9	1.6		0	2997	2997	0.80	0.6	25	0.1	0.3	0.2		0.85	51	153	186	44
29.0	2	6.6		2.0	6.4		0	3108	3108	2.17	1.4	152				29.9	0.85	318			270
30.0	4.5	12		4.4	11.8		0	3226	3226	1.70	2.8	258				34.2	1.30	538			698
31.0	5.6	14.2		5.4	14		62	3347	3284	1.59	3.4	298				35.2	1.47	622			915
32.0	5.25	15.4	0	5.0	15.2		125	3468	3343	2.07	3.1	354				34.6	1.41	740			1040
33.0	4.4	11.2		4.3	11		187	3586	3398	1.59	2.6	232				33.7	1.20	485			584
34.0	6.25	17		6.0	16.8		250	3708	3458	1.86	3.5	376				35.4	1.52	786			1192
35.0	4.5	12.4		4.4	12.2		312	3826	3514	1.87	2.5	272				33.5	1.19	569			678
36.0	3.95	13.8	0	3.7	13.6		374	3945	3571	2.81	2.1	343				32.4	1.11	717			795
37.0	2.35	9.8		2.2	9.6		437	4059	3622	3.66	1.2	256				28.9	0.85	535			454
38.0	3.75	10.8		3.6	10.6		499	4176	3677	2.04	1.9	241				32.0	0.97	504			489
39.0	5.8	14.2		5.6	14		562	4296	3735	1.56	3.0	291				34.5	1.34	607			813
40.0	3.15	9.7	0.15	3.1	9.5	0.38	624	4411	3787	2.32	1.5	223				30.6	0.85	466			396

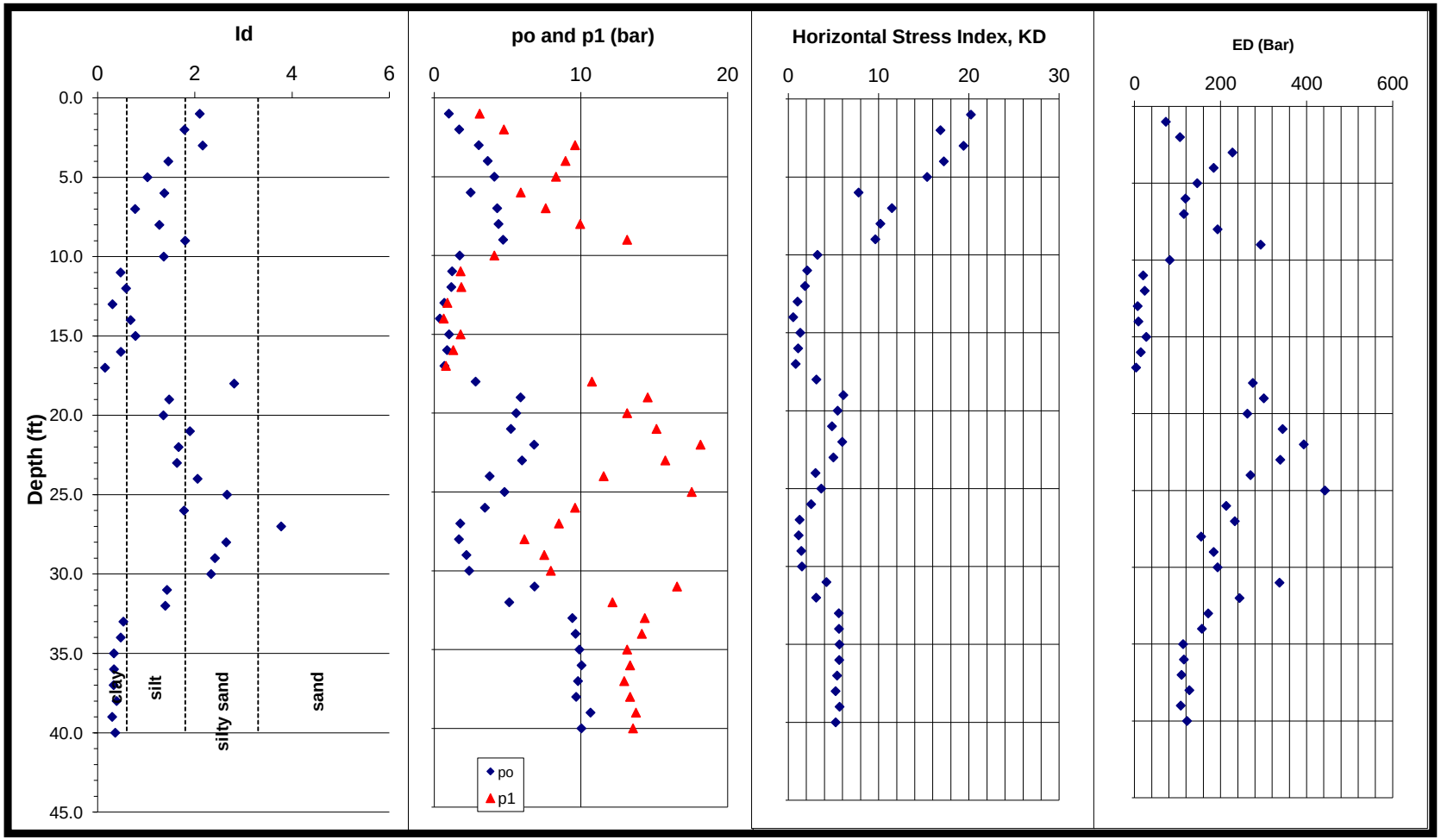
DILATOMETER TEST RESULTS

Test ID: DMT-3
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



DILATOMETER TEST RESULTS

Test ID: DMT-3
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



Job No: 12-951
Job Name: MCSFRC Yorktown
Job Location: Yorktown, VA
Date: 6/26/12
Sounding No: DMT-3
Ground Water Depth (ft): 30

	Membrane 1	Membrane 2	Membrane 3	
ΔA =	0.2	0	0	bar
ΔB =	0.25	0	0	bar
Zm=	0 bar			

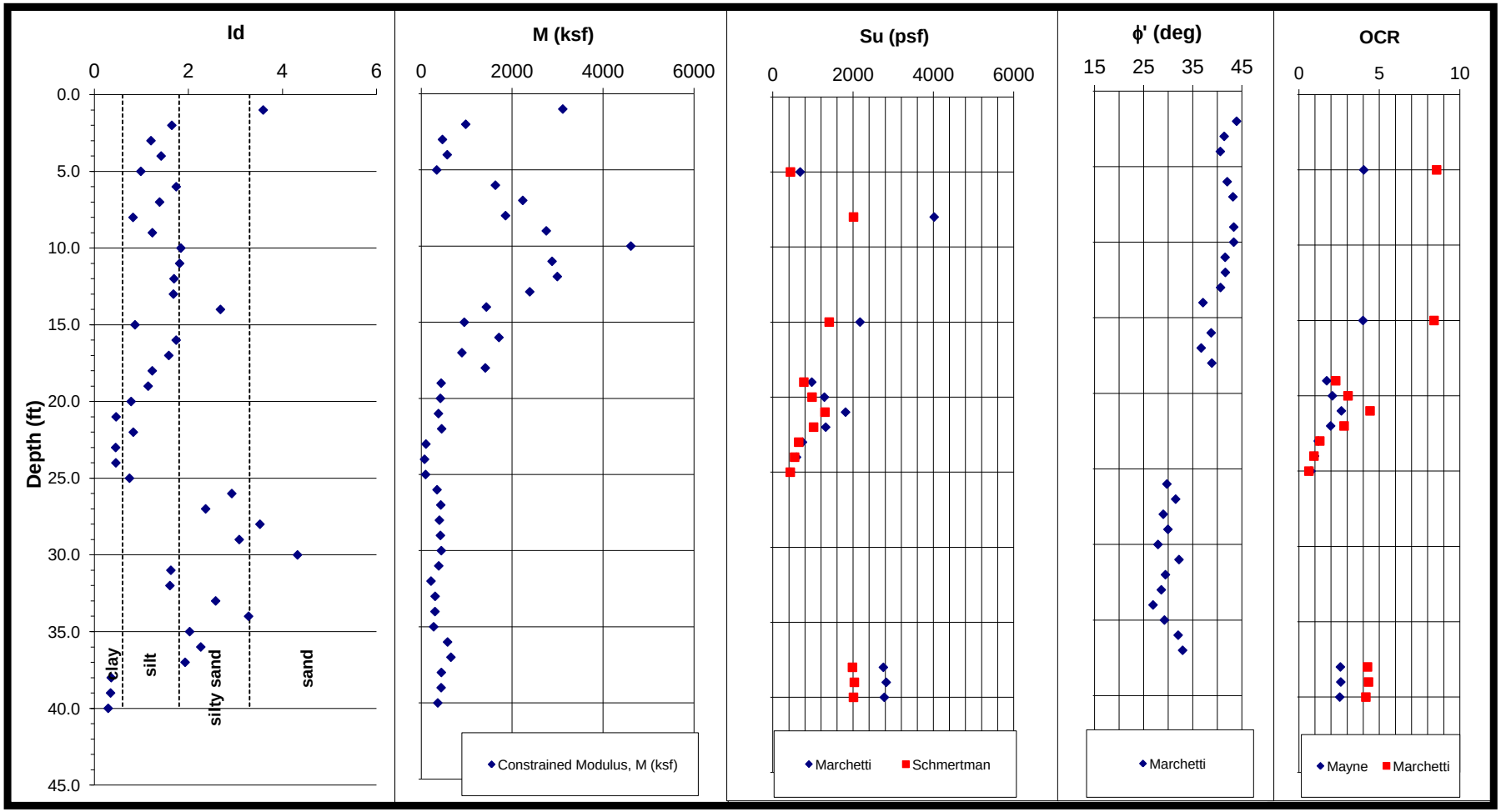
[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

CONETEC

Depth[1] (ft)	A (bar)	B (bar)	C (bar)	po (bar)	p1 (bar)	p2 (bar)	u_o (psf)	σ_{vo} (psf)	σ_{vo}' (psf)	Id	K_D	E_D (bar)	K_o	OCR[2]	OCR[3]	ϕ'[4] (deg)	R_M	E_D (ksf)	s_u[6] (psf)	s_u[7] (psf)	M (ksf)
1.0	0.9	3.35		1.0	3.1		0	103	103	2.10	20.2	73				43.5	3.17	152			482
2.0	1.65	5		1.7	4.75		0	211	211	1.79	16.9	106				42.7	2.99	221			661
3.0	3.15	9.85		3.0	9.6		0	327	327	2.16	19.4	228				43.3	3.13	476			1488
4.0	3.7	9.2	0	3.6	8.95		0	442	442	1.45	17.2	184				42.8	3.01	384			1159
5.0	4.1	8.55		4.1	8.3		0	557	557	1.02	15.4	146	2.4	7.8	24.1		2.91	304	1568	856	885
6.0	2.45	6.15		2.5	5.9		0	668	668	1.37	7.8	118				39.3	2.26	247			558
7.0	4.25	7.85		4.3	7.6		0	781	781	0.77	11.5	115	2.0	5.8	15.3		2.63	240	1526	897	630
8.0	4.45	10.2	0	4.4	9.95		0	898	898	1.27	10.2	193				40.6	2.52	403			1016
9.0	4.9	13.4		4.7	13.15		0	1018	1018	1.80	9.6	293				40.3	2.47	613			1510
10.0	1.65	4.35		1.7	4.1		0	1125	1125	1.36	3.2	82				34.9	1.40	171			239
11.0	1.05	2.05		1.2	1.8		0	1222	1222	0.47	2.1	20	0.6	1.1	1.1		0.89	42	284	255	37
12.0	1	2.1	0.05	1.2	1.85	0.25	0	1321	1321	0.58	1.8	24	0.5	0.9	0.9		0.85	49	263	244	42
13.0	0.5	1.15		0.7	0.9		0	1411	1411	0.30	1.0	7	0.2	0.5	0.4		0.85	15	134	144	13
14.0	0.2	0.9		0.4	0.65		0	1500	1500	0.68	0.5	9	0.0	0.3	0.1		0.85	19	64	81	16
15.0	0.85	2.05		1.0	1.8		0	1598	1598	0.78	1.3	27	0.3	0.7	0.5		0.85	57	210	211	49
16.0	0.7	1.55	0	0.9	1.3		0	1693	1693	0.48	1.1	15	0.3	0.6	0.4		0.85	30	174	184	26
17.0	0.5	1.05		0.7	0.8		0	1780	1780	0.15	0.8	4	0.2	0.4	0.2		0.85	8	128	145	6
18.0	3	11		2.8	10.75		0	1896	1896	2.81	3.1	275				34.7	1.47	575			845
19.0	6.1	14.8		5.9	14.55		0	2018	2018	1.47	6.1	301				38.2	2.02	628			1268
20.0	5.75	13.4	0	5.6	13.15		0	2138	2138	1.35	5.5	262				37.6	1.91	548			1046
21.0	5.5	15.4		5.2	15.15		0	2259	2259	1.90	4.8	344				37.0	1.82	719			1306
22.0	7.15	18.4		6.8	18.15		0	2383	2383	1.67	6.0	393				38.1	2.01	822			1649
23.0	6.25	16		6.0	15.75		0	2504	2504	1.63	5.0	339				37.2	1.83	708			1298
24.0	3.95	11.8	0	3.8	11.55		0	2622	2622	2.06	3.0	270				34.5	1.38	563			779
25.0	5.2	17.8		4.8	17.55		0	2745	2745	2.66	3.6	443				35.5	1.60	925			1481
26.0	3.55	9.85		3.5	9.6		0	2860	2860	1.78	2.5	213				33.5	1.19	445			532
27.0	1.9	8.75		1.8	8.5		0	2973	2973	3.78	1.3	233				29.4	0.85	487			414
28.0	1.7	6.4	0.1	1.7	6.15	0.30	0	3083	3083	2.64	1.1	155				28.8	0.85	323			275
29.0	2.25	7.75		2.2	7.5		0	3196	3196	2.41	1.4	184				30.2	0.85	384			327
30.0	2.45	8.2		2.4	7.95		0	3309	3309	2.33	1.5	193				30.5	0.85	403			343
31.0	7.1	16.8		6.8	16.55		62	3432	3369	1.43	4.2	337				36.3	1.66	704			1170
32.0	5.25	12.4	0	5.1	12.15		125	3551	3426	1.39	3.1	244				34.6	1.35	510			690
33.0	9.45	14.6		9.4	14.35		187	3671	3484	0.53	5.6	171	1.3	2.8	5.0		1.90	358	2770	1948	681
34.0	9.65	14.4		9.6	14.15		250	3791	3542	0.47	5.6	157	1.3	2.9	5.0		1.91	327	2829	1987	624
35.0	9.85	13.4		9.9	13.15		312	3910	3598	0.33	5.7	113	1.3	2.9	5.1		1.92	236	2904	2035	452
36.0	10	13.6	6.4	10.0	13.35	6.60	374	4028	3654	0.34	5.6	115	1.3	2.9	5.0		1.91	240	2936	2060	458
37.0	9.75	13.2		9.8	12.95		437	4146	3709	0.33	5.4	109	1.2	2.7	4.7		1.87	228	2824	2003	427
38.0	9.65	13.6		9.7	13.35		499	4265	3766	0.39	5.2	128	1.2	2.7	4.5		1.84	266	2757	1971	489
39.0	10.6	14		10.7	13.75		562	4383	3822	0.30	5.7	107	1.3	2.9	5.1		1.92	224	3096	2169	431
40.0	10	13.8	6.1	10.0	13.55	6.30	624	4502	3878	0.36	5.2	122	1.2	2.7	4.5		1.84	255	2845	2033	469

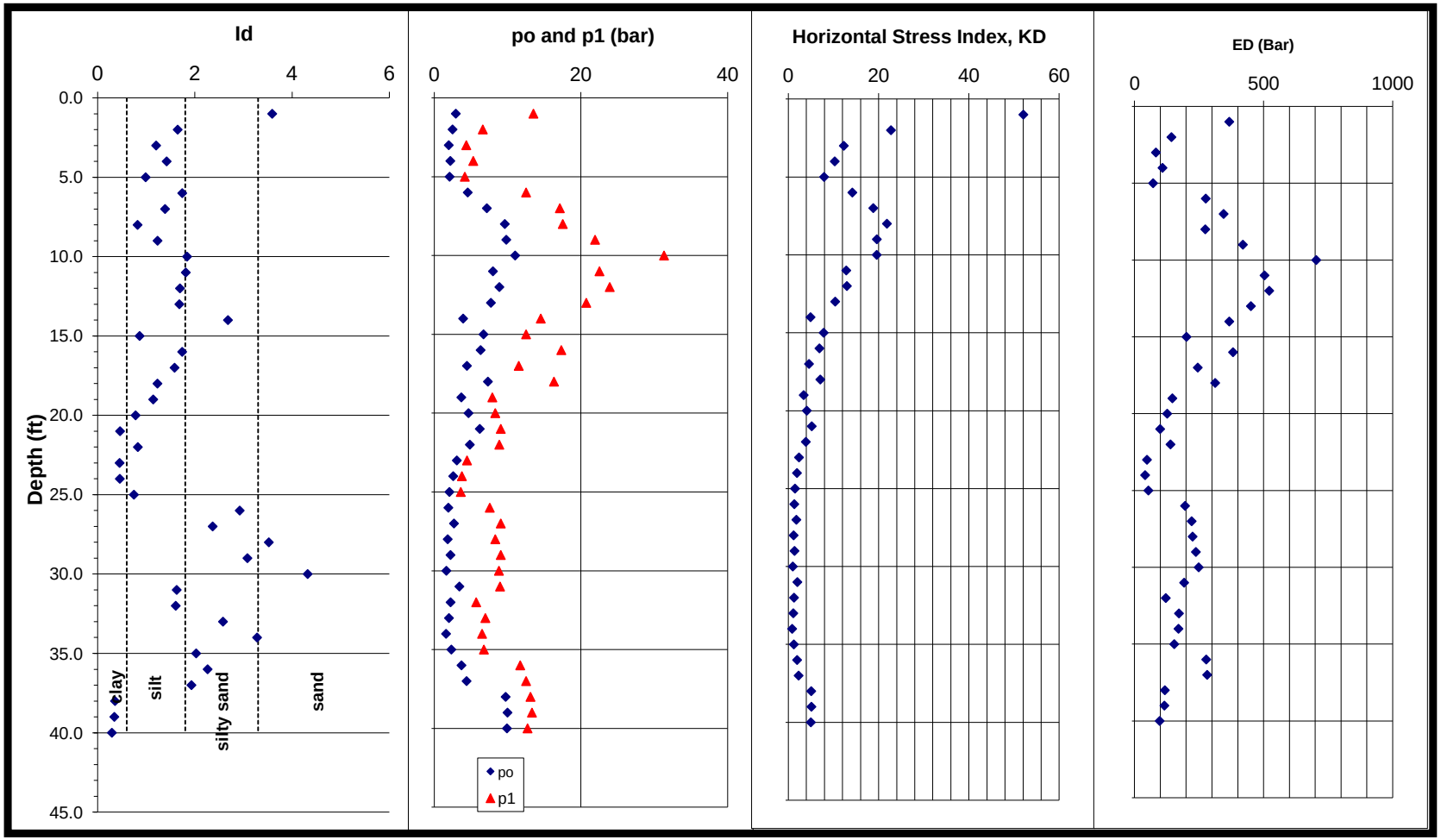
DILATOMETER TEST RESULTS

Test ID: DMT-4
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



DILATOMETER TEST RESULTS

Test ID: DMT-4
Site: MCSFRC Yorktown
Location: Yorktown, VA
Project No.: 12-951



Job No: 12-951
Job Name: MCSFRC Yorktown
Job Location: Yorktown, VA
Date: 6/27/12
Sounding No: DMT-4
Ground Water Depth (ft): 30

	Membrane 1	Membrane 2	Membrane 3	
ΔA =	0.2	0	0	bar
ΔB =	0.275	0	0	bar
Zm=	0 bar			

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

CONETEC

Depth[1] (ft)	A (bar)	B (bar)	C (bar)	po (bar)	p1 (bar)	p2 (bar)	u_o (psf)	σ_{vo} (psf)	σ_{vo}' (psf)	Id	K_D	E_D (bar)	K_o	OCR[2]	OCR[3]	ϕ'[4] (deg)	R_M	E_D (ksf)	s_u[6] (psf)	s_u[7] (psf)	M (ksf)
1.0	3.25	13.8		2.9	13.525		0	118	118	3.59	52.1	367				46.9	4.06	767			3114
2.0	2.5	6.9		2.5	6.625		0	230	230	1.65	22.7	143				43.9	3.28	299			979
3.0	1.9	4.65		2.0	4.375		0	338	338	1.20	12.3	83				41.4	2.70	173			467
4.0	2.15	5.6	0	2.2	5.325		0	447	447	1.42	10.3	108				40.6	2.53	226			572
5.0	2	4.45		2.1	4.175		0	554	554	0.99	7.9	72	1.6	4.0	8.6		2.27	150	681	439	341
6.0	4.75	12.8		4.6	12.525		0	673	673	1.74	14.2	276				42.0	2.83	576			1632
7.0	7.45	17.4		7.2	17.125		0	797	797	1.39	18.8	345				43.2	3.10	721			2234
8.0	9.8	17.8	0	9.6	17.525		0	920	920	0.82	21.8	274	2.9	11.1	41.7		3.24	573	4019	2010	1855
9.0	10.2	22.2		9.8	21.925		0	1046	1046	1.23	19.6	420				43.4	3.14	877			2752
10.0	11.8	31.6		11.0	31.325		0	1177	1177	1.84	19.6	704				43.4	3.14	1471			4612
11.0	8.5	22.8		8.0	22.525		0	1303	1303	1.81	12.8	504				41.6	2.74	1052			2879
12.0	9.4	24.2	0	8.9	23.925		0	1430	1430	1.69	13.0	522				41.6	2.75	1090			2994
13.0	8.15	21		7.7	20.725		0	1556	1556	1.68	10.4	451				40.7	2.54	942			2387
14.0	4.25	14.8		3.9	14.525		0	1675	1675	2.68	4.9	367				37.1	1.87	767			1433
15.0	6.8	12.8		6.7	12.525		0	1795	1795	0.86	7.8	201	1.6	4.0	8.4		2.25	420	2172	1404	947
16.0	6.65	17.6	0	6.3	17.325		0	1918	1918	1.74	6.9	382				38.8	2.15	797			1710
17.0	4.6	11.8		4.5	11.525		0	2036	2036	1.58	4.6	245				36.7	1.75	512			895
18.0	7.55	16.6		7.3	16.325		0	2159	2159	1.23	7.1	312				38.9	2.16	653			1410
19.0	3.7	8.2		3.7	7.925		0	2273	2273	1.14	3.4	147	0.9	1.7	2.3		1.43	306	970	772	439
20.0	4.65	8.6	0.45	4.7	8.325	0.65	0	2388	2388	0.78	4.1	127	1.0	2.1	3.1		1.59	264	1285	977	422
21.0	6.15	9.35		6.2	9.075		0	2503	2503	0.46	5.2	99	1.2	2.6	4.4		1.83	207	1811	1298	379
22.0	4.85	9.15		4.9	8.875		0	2618	2618	0.83	3.9	139	1.0	2.0	2.8		1.54	291	1317	1015	449
23.0	2.95	4.75		3.1	4.475		0	2725	2725	0.45	2.4	48	0.6	1.2	1.3		1.02	101	739	644	103
24.0	2.45	4.05	0.55	2.6	3.775	0.75	0	2830	2830	0.46	1.9	41	0.5	1.0	0.9		0.85	86	589	542	73
25.0	1.95	3.9		2.1	3.625		0	2936	2936	0.75	1.5	54	0.4	0.8	0.6		0.85	112	442	434	95
26.0	2	7.85		1.9	7.575		0	3048	3048	2.92	1.3	196				29.7	0.85	409			348
27.0	2.8	9.35		2.7	9.075		0	3163	3163	2.37	1.8	221				31.5	0.93	462			430
28.0	1.95	8.6	0	1.8	8.325		0	3275	3275	3.52	1.2	225				29.0	0.85	470			399
29.0	2.35	9.35		2.2	9.075		0	3389	3389	3.08	1.4	238				30.0	0.85	497			422
30.0	1.8	9.1		1.7	8.825		0	3502	3502	4.32	1.0	249				27.9	0.85	519			441
31.0	3.5	9.25		3.4	8.975		62	3617	3555	1.63	2.0	192				32.2	0.96	401			385
32.0	2.2	6	0	2.2	5.725		125	3728	3603	1.61	1.3	121				29.4	0.85	253			215
33.0	2.05	7.25		2.0	6.975		187	3839	3652	2.58	1.1	172				28.6	0.85	360			306
34.0	1.65	6.8		1.6	6.525		250	3949	3699	3.28	0.8	170				26.9	0.85	356			302
35.0	2.35	7.05		2.3	6.775		312	4060	3748	2.03	1.2	154				29.2	0.85	322			273
36.0	3.9	12	0	3.7	11.725		374	4178	3804	2.26	1.9	278				32.0	1.00	580			579
37.0	4.6	12.8		4.4	12.525		437	4297	3860	1.93	2.3	281				32.9	1.11	588			653
38.0	9.7	13.4		9.7	13.125		499	4415	3916	0.36	5.1	118	1.2	2.6	4.3		1.80	245	2753	1984	443
39.0	9.95	13.6		10.0	13.325		562	4533	3972	0.34	5.1	116	1.2	2.6	4.3		1.81	242	2824	2031	438
40.0	9.85	13	6.4	9.9	12.725	6.60	624	4651	4027	0.29	5.0	97	1.2	2.5	4.2		1.79	204	2777	2009	364

CPTu SOUNDINGS

References: ASTM D 5778, "**Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils**," Annual Book of ASTM Standards, Vol. 04.08, American Society for Testing and Materials, January 1996.

Lunne, T., Robertson, P.K., and Powell, J.J.M., "**Cone Penetration Testing in Geotechnical Practice**," Spoon Press, 1997.

Riaund, J. L. and Miran, J., "**The Cone Penetrometer Test**," Publication No. FHWA-SA-91-043, Final Report, U.S. Department of Transportation, Federal Highway Administration, February 1992.

Contractor: ConeTec, Inc.

Procedures: The CPT is a profiling tool described in ASTM D 5778 and various other publications. No physical soil sampling is conducted during the test. A compression model electronic piezocone penetrometer with a 15 cm^2 tip and a 225 cm^2 friction sleeve was used. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.8. Prior to testing, the cone internal force transducers were calibrated in a laboratory. At the beginning of each sounding, the cone was outfitted with a vacuum-saturated, 6 mm thick porous plastic pore pressure element that is located immediately behind the tip (the u_2 location). The cone was advanced using a 15-ton hydraulic ramset mounted in a 25-ton truck or on a 20-ton tracked vehicle. As the cone was advanced into the ground, tip resistance (qc), sleeve friction (fs) and dynamic pore water pressure (u) were recorded every 2.5 centimeters (approximately every one inch).

Limitations: The enclosed testing records represent an interpretation of the subsurface conditions encountered at the specific testing locations at the time explorations were made. It is possible that subsurface conditions between testing locations will be different from those indicated. Strata contacts and surface elevations, if shown, shall be considered approximate and are referenced to project datum shown on the plans or described in the geotechnical report unless noted otherwise.

CPT SOIL BEHAVIOR TYPE (SBT)

KEY TO SBT COLORS SHOWN ON CPT LOGS

CPT RESISTANCE PROFILE LEGEND – NORMALIZED

- Sensitive Fine Grained (Silts & Clays)
- Organic Soils to Peat
- Clay – Clay to Silty Clay
- Silt Mixtures – Clayey Silt to Silty Clay
- Sand Mixtures–Silty Sand to Sandy Silt
- Sand – Clean Sand to Silty Sand
- Gravelly Sand to Sand
- Very Stiff Clay to Clayey Sand
- Very Stiff Fine Grained Soils
- Very Stiff Clay to Clayey Sand

CPT RESISTANCE PROFILE LEGEND – NON–NORMALIZED

- Sensitive Fine Grained (Silts & Clays)
- Organic Soils to Peat
- Clay
- Clay to Silty Clay
- Clayey Silt to Silty Clay
- Sandy Silt to Clayey Silt
- Silty Sand to Sandy Silt
- Sand to Silty Sand
- Sand
- Gravelly Sand to Sand
- Very Stiff Fine Grained (Silt & Clay)
- Very Dense Sand to Clayey Sand

• **Notes**

Soil behavior type is the classification of the soil based on its behavior and not necessarily the actual soil type.

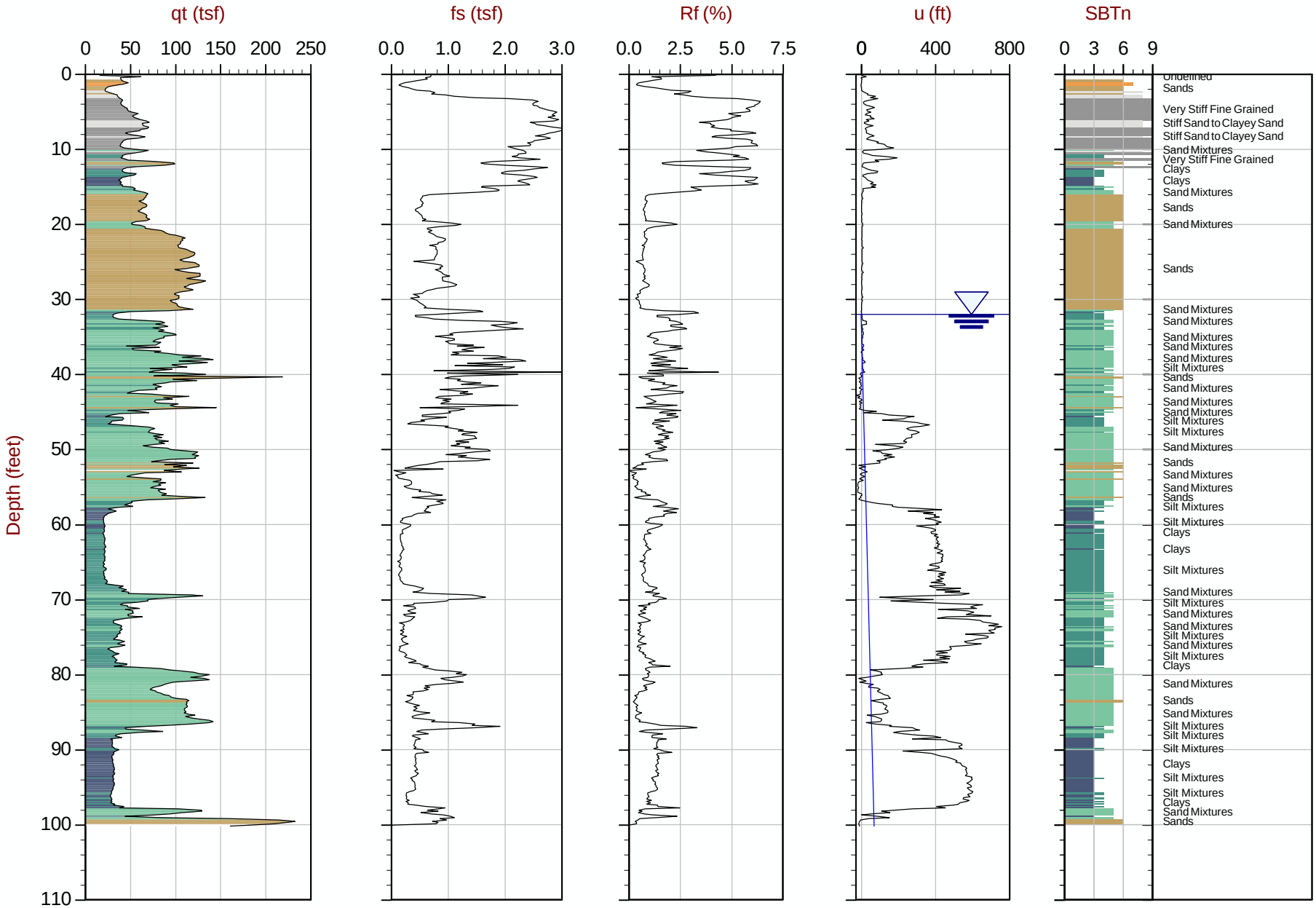
GER

CONETEC

GER

Job No: 12-951
Date: 06:22:12 22:59
Site: MCSFRC Yorktown

Sounding: SCPTU-1
Cone: 304:T1500F15U500



Max Depth: 30.550 m / 100.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 951CP01.COR
Unit Wt: SBT Chart Soil Zones

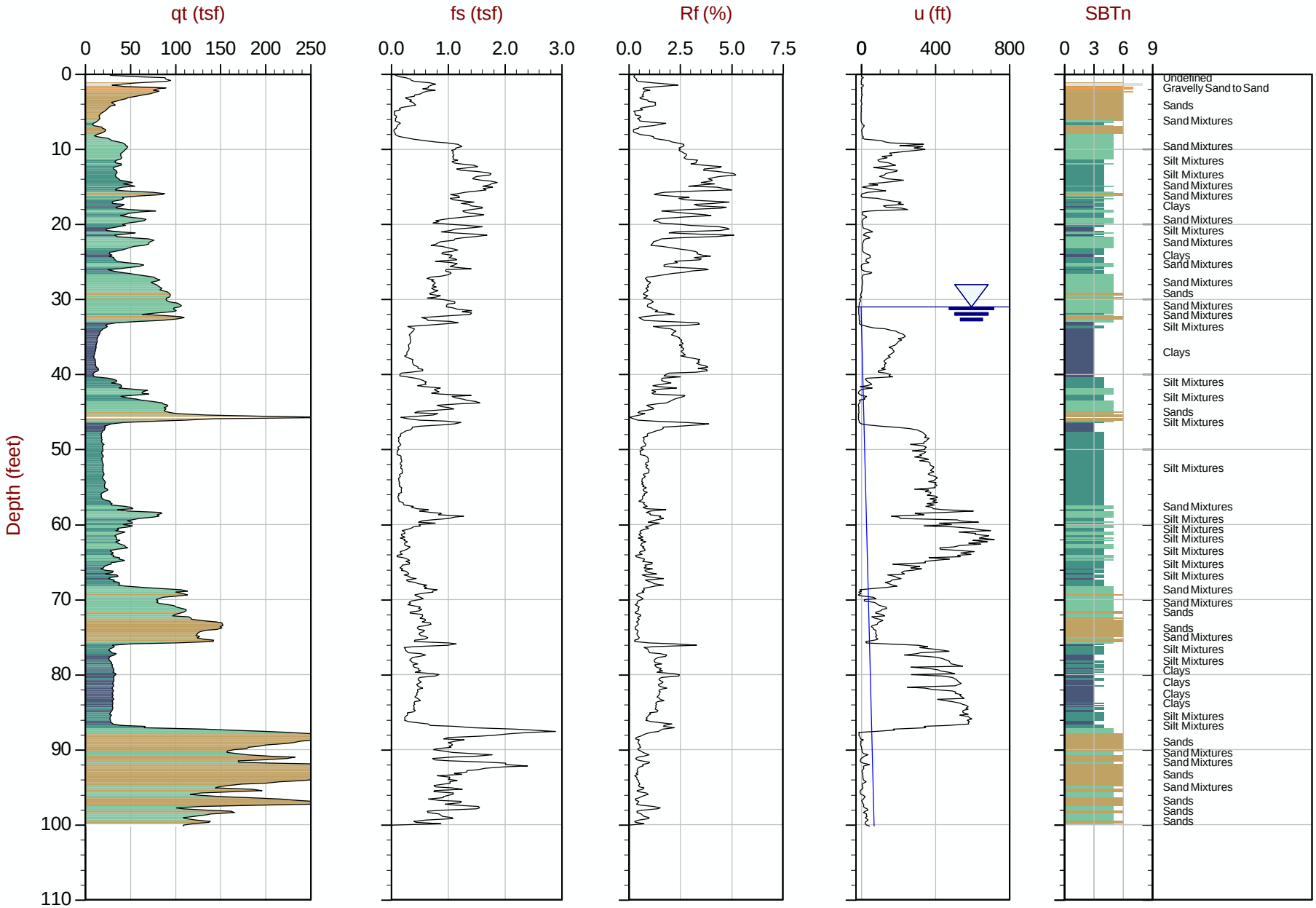
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

CONETEC

GER

Job No: 12-951
Date: 06:25:12 20:43
Site: MCSFRC Yorktown

Sounding: SCPTU-2
Cone: 304:T1500F15U500



Max Depth: 30.550 m / 100.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 951CP02.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

SHEAR WAVE VELOCITY TESTS

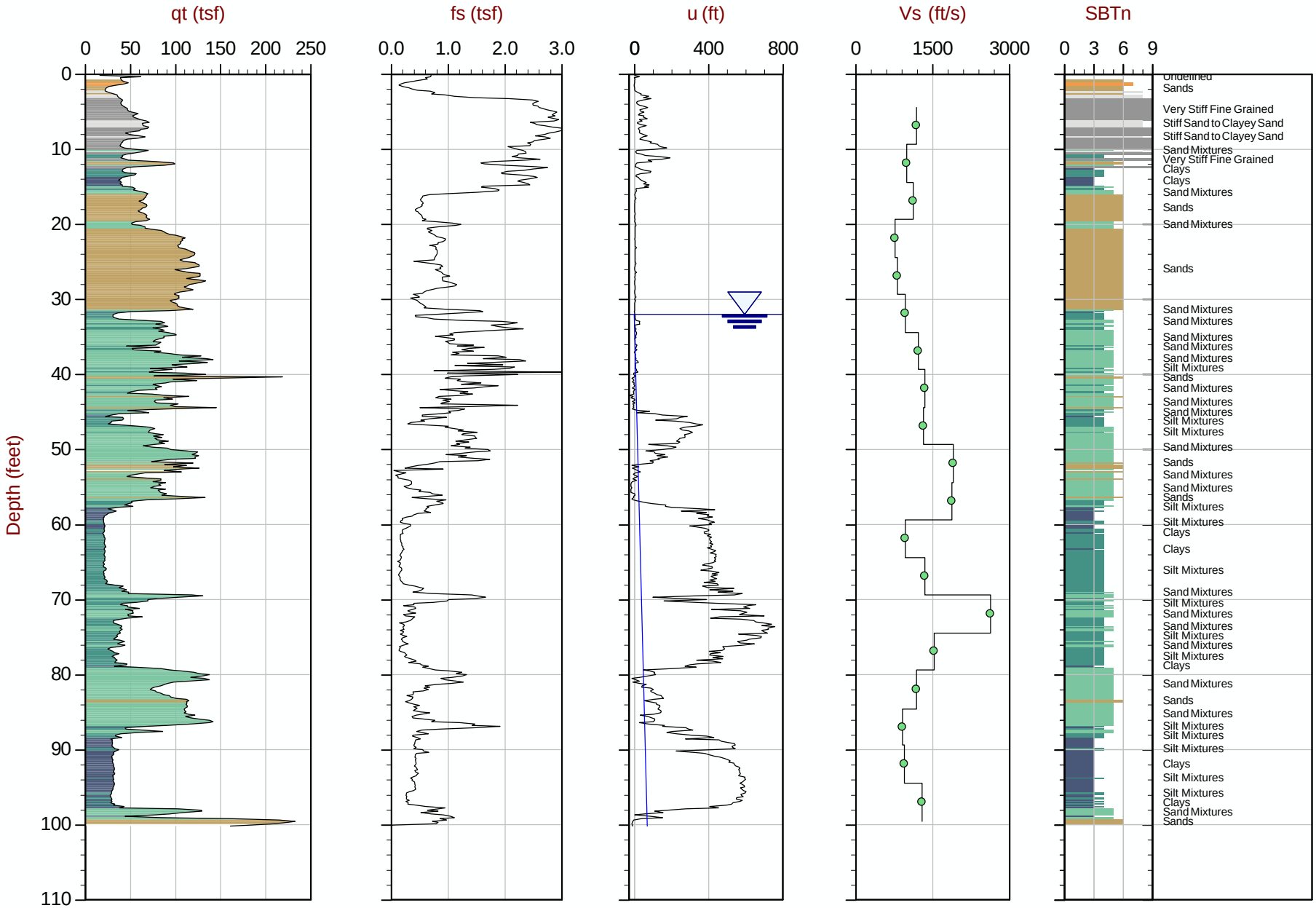
GER

CONETEC

GER

Job No: 12-951
Date: 06:22:12 22:59
Site: MCSFRC Yorktown

Sounding: SCPTU-1
Cone: 304:T1500F15U500

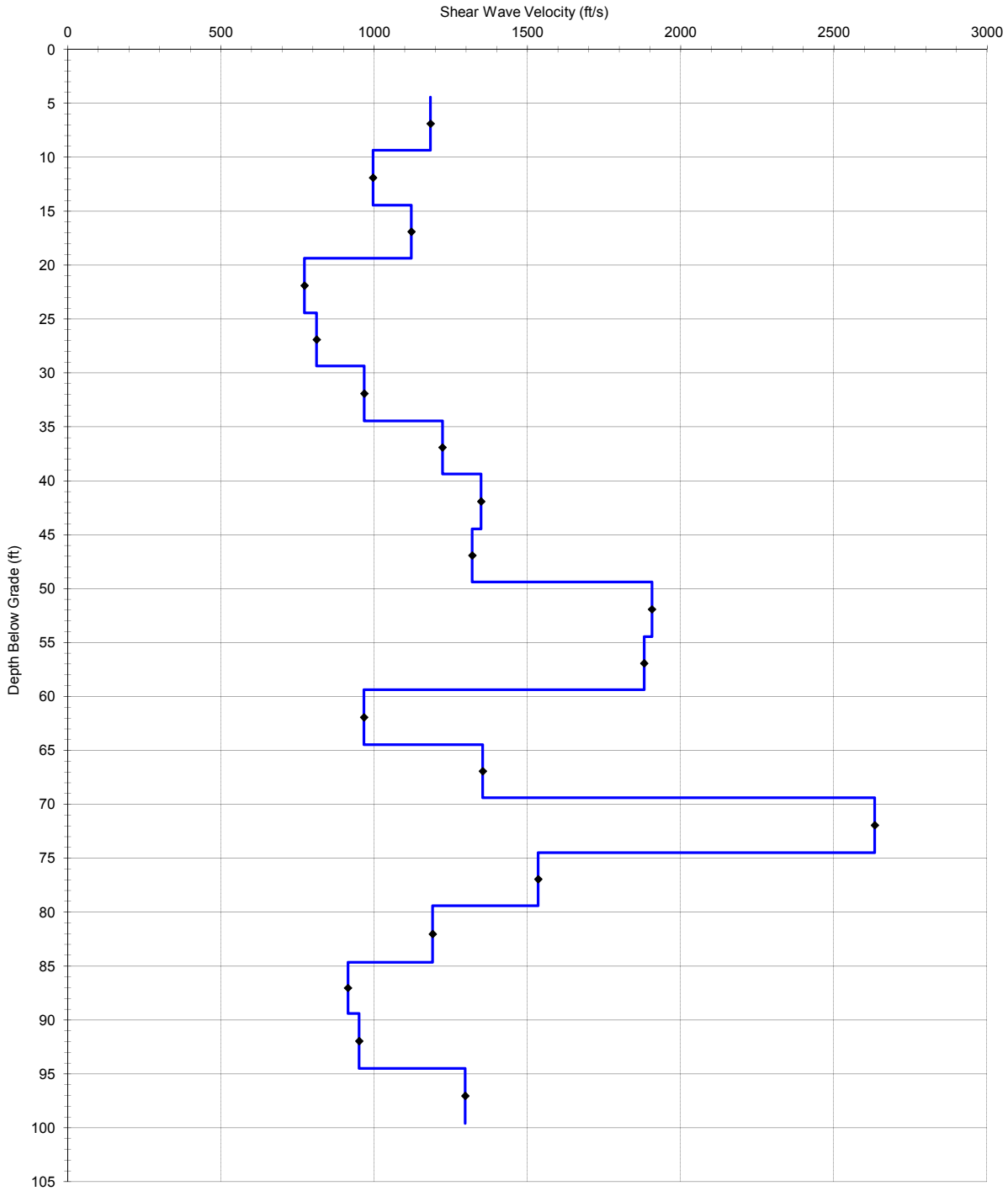


Max Depth: 30.550 m / 100.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 951CP01.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

Shear Wave Velocity- SCPT-01
MCSFRC Yorktown
12-951
June 22, 2012

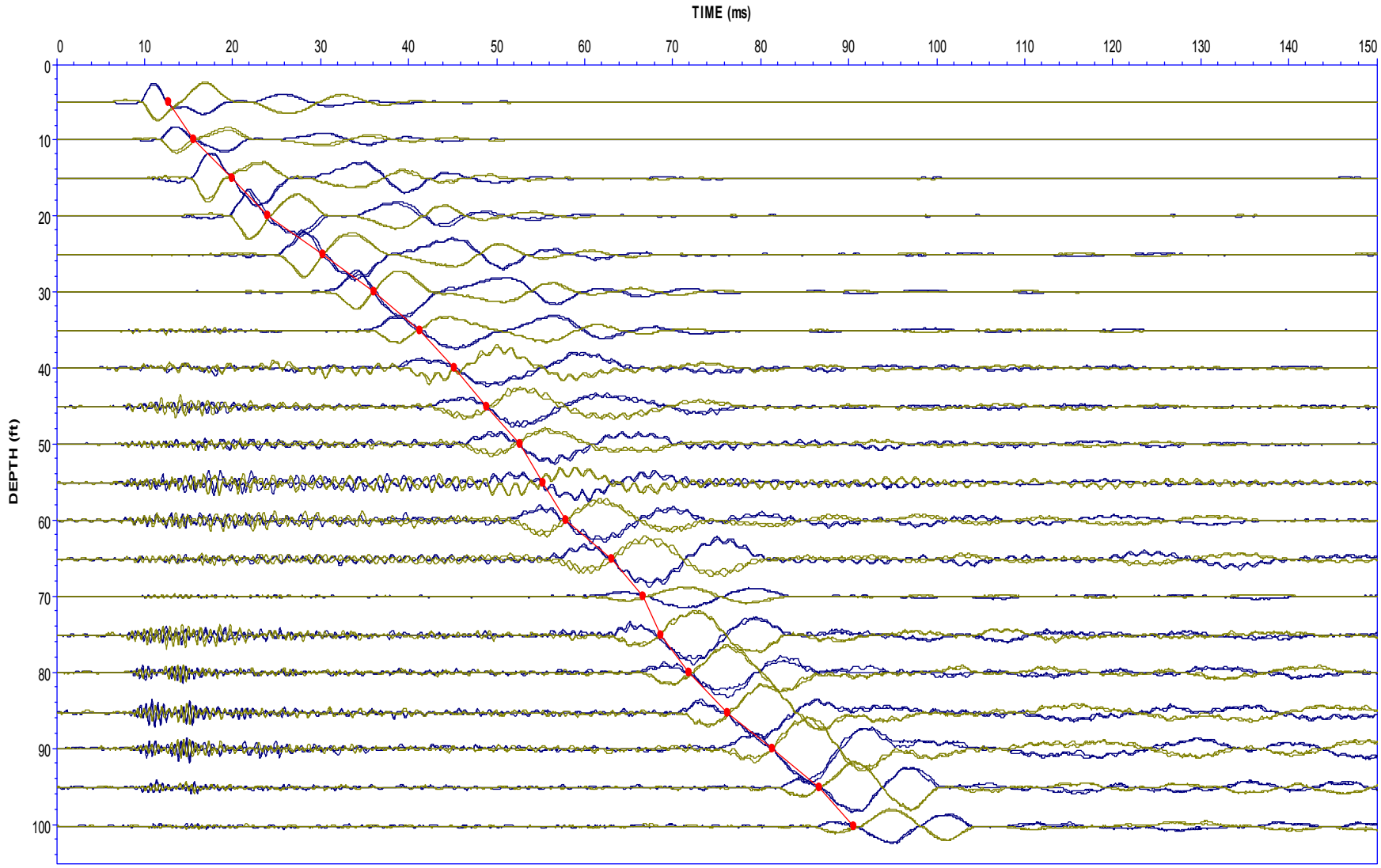


ConeTec Shear Wave Velocity Data Reduction Sheet

Hole:	SCPT-01
Location:	MCSFRC Yorktown
Cone:	AD 304
Date:	22-Jun-12
Source:	Beam
Source Depth	0.00 m
Source Offset	2.15 m

Tip Depth (m)	Geophone Depth(m)	Travel Path (m)	Interval time (ms)	Velocity (m/s)	Velocity (ft/s)	Interval Depth (m)	Interval Depth (ft)
0.00							
1.55	1.35	2.54					
3.05	2.85	3.57	2.86	360.9	1184.0	2.10	6.89
4.60	4.40	4.90	4.37	303.7	996.2	3.62	11.89
6.10	5.90	6.28	4.04	341.8	1121.4	5.15	16.90
7.65	7.45	7.75	6.26	235.5	772.6	6.67	21.90
9.15	8.95	9.20	5.86	247.6	812.2	8.20	26.90
10.70	10.50	10.72	5.13	295.0	967.9	9.72	31.91
12.20	12.00	12.19	3.95	372.7	1222.7	11.25	36.91
13.75	13.55	13.72	3.72	411.2	1348.9	12.77	41.91
15.25	15.05	15.20	3.69	402.4	1320.1	14.30	46.92
16.80	16.60	16.74	2.64	581.0	1906.3	15.82	51.92
18.30	18.10	18.23	2.60	573.4	1881.2	17.35	56.92
19.85	19.65	19.77	5.23	294.7	967.0	18.87	61.92
21.35	21.15	21.26	3.61	412.8	1354.3	20.40	66.93
22.90	22.70	22.80	1.92	802.7	2633.6	21.92	71.93
24.40	24.20	24.30	3.19	467.9	1535.2	23.45	76.93
26.00	25.80	25.89	4.39	363.0	1190.8	25.00	82.02
27.45	27.25	27.33	5.19	278.7	914.3	26.53	87.02
29.00	28.80	28.88	5.33	289.9	951.0	28.03	91.94
30.55	30.35	30.43	3.91	395.4	1297.1	29.57	97.03

Job No: 12-951 Client: GER Project Title: MCSFRC Yorktown Operator: BK-TS Hole: SCPTU-1 Site: MCSFRC Yorktown Date: 06:22:12 22:59
Oversite: 304:T1500F15U500

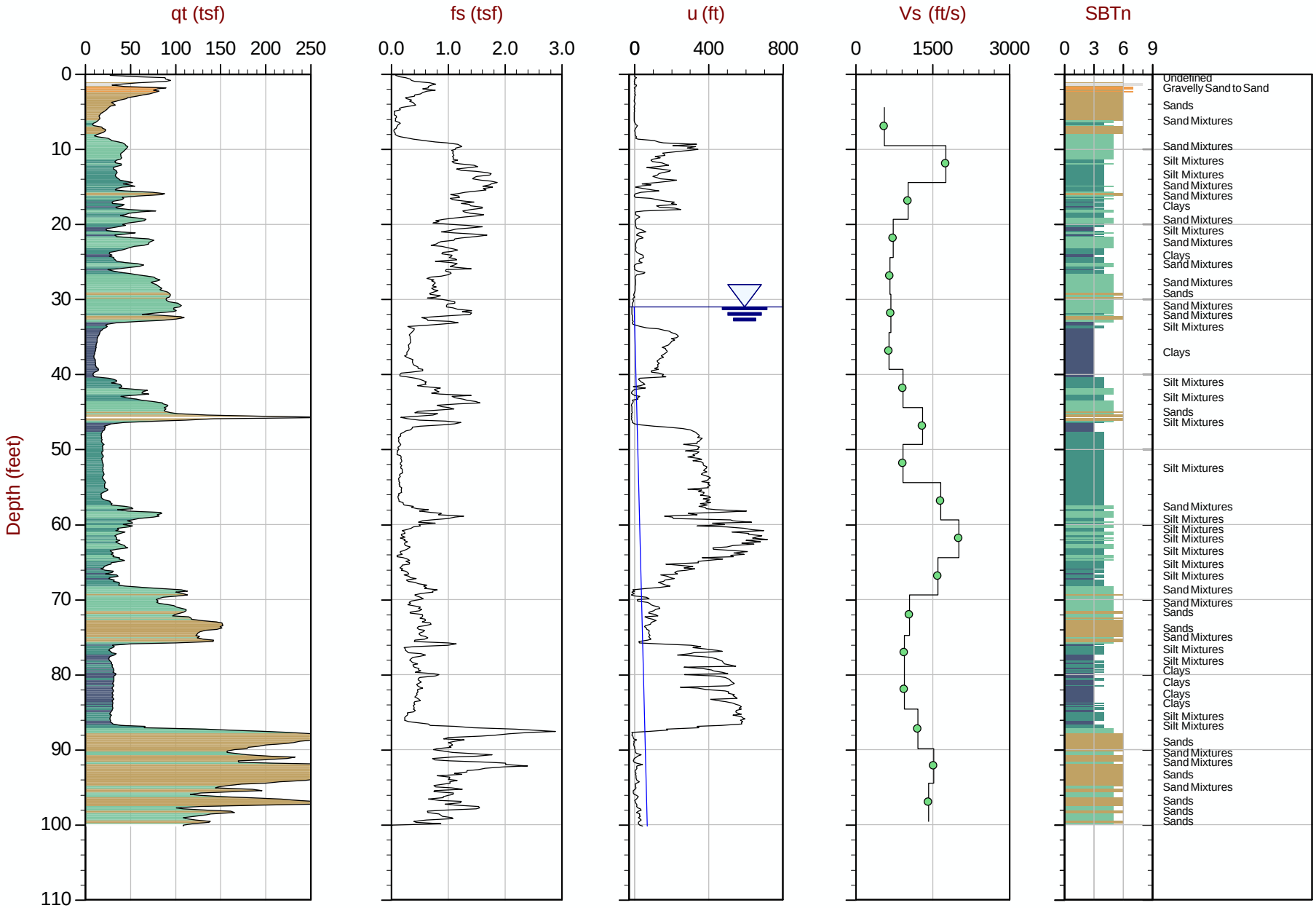


CONETEC

GER

Job No: 12-951
Date: 06:25:12 20:43
Site: MCSFRC Yorktown

Sounding: SCPTU-2
Cone: 304:T1500F15U500

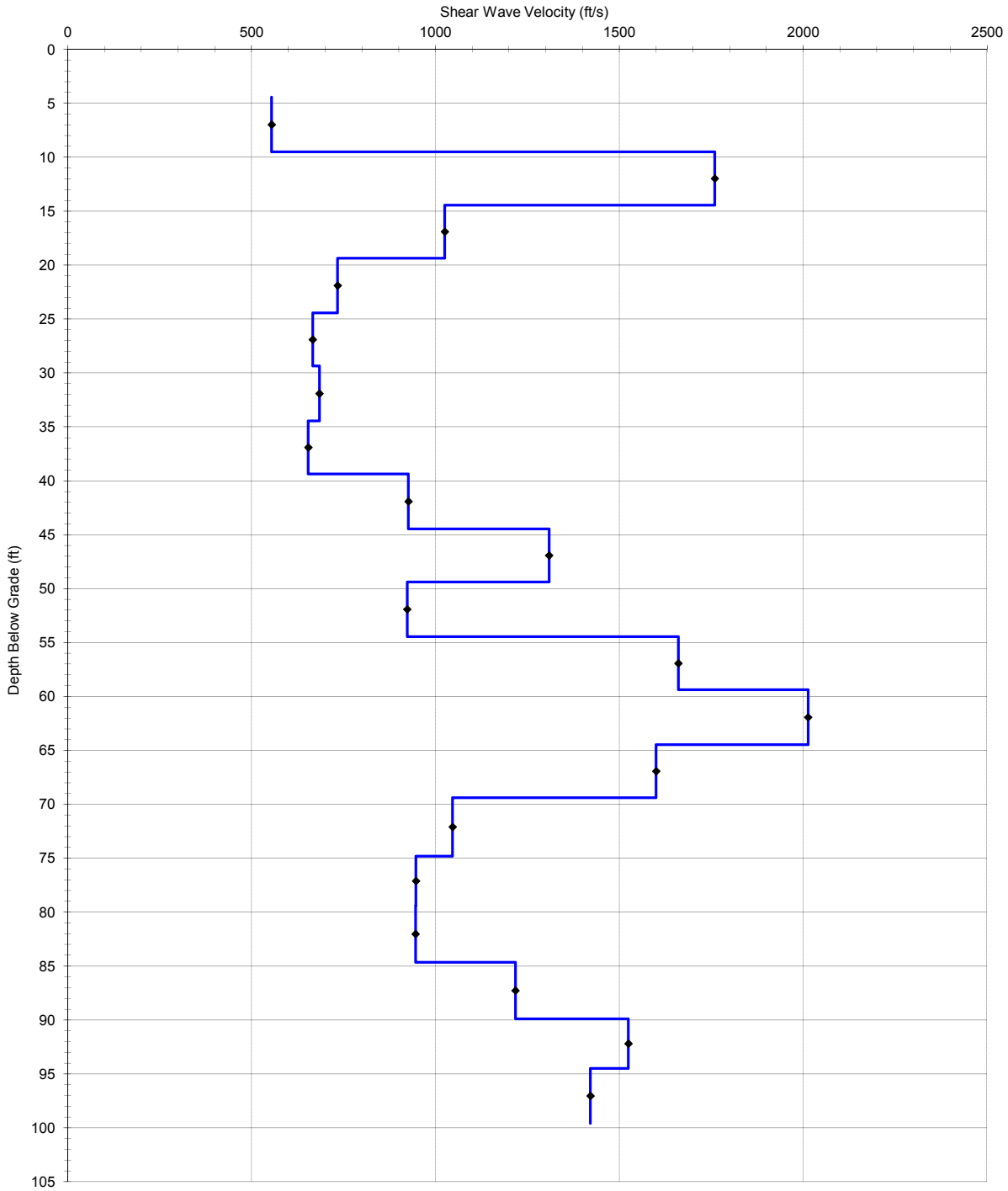


Max Depth: 30.550 m / 100.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 951CP02.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

Shear Wave Velocity- SCPT-02
MCSFRC Yorktown
12-951
June 25, 2012

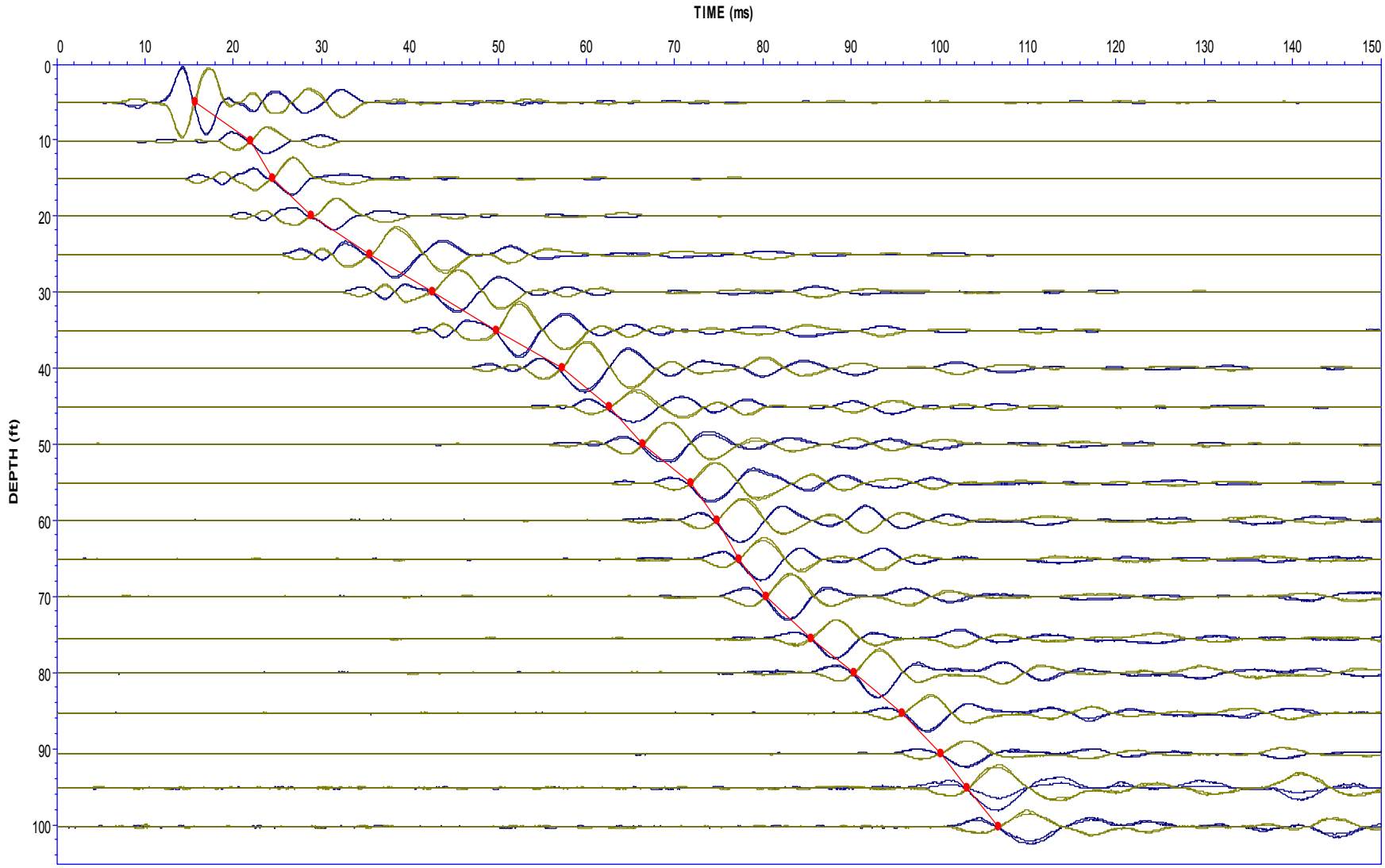


ConeTec Shear Wave Velocity Data Reduction Sheet

Hole:	SCPT-02
Location:	MCSFRC Yorktown
Cone:	AD 304
Date:	25-Jun-12
Source:	Beam
Source Depth	0.00 m
Source Offset	2.15 m

Tip Depth (m)	Geophone Depth(m)	Travel Path (m)	Interval time (ms)	Velocity (m/s)	Velocity (ft/s)	Interval Depth (m)	Interval Depth (ft)
0.00							
1.55	1.35	2.54					
3.10	2.90	3.61	6.34	169.1	554.7	2.12	6.97
4.60	4.40	4.90	2.40	536.3	1759.5	3.65	11.97
6.10	5.90	6.28	4.42	312.5	1025.2	5.15	16.90
7.65	7.45	7.75	6.59	223.7	734.0	6.67	21.90
9.15	8.95	9.20	7.14	203.0	666.1	8.20	26.90
10.70	10.50	10.72	7.25	208.6	684.5	9.72	31.91
12.20	12.00	12.19	7.39	199.4	654.2	11.25	36.91
13.75	13.55	13.72	5.41	282.4	926.6	12.77	41.91
15.25	15.05	15.20	3.72	399.0	1309.0	14.30	46.92
16.80	16.60	16.74	5.46	281.3	923.0	15.82	51.92
18.30	18.10	18.23	2.94	506.1	1660.5	17.35	56.92
19.85	19.65	19.77	2.51	613.6	2013.2	18.87	61.92
21.35	21.15	21.26	3.06	487.7	1600.0	20.40	66.93
23.00	22.80	22.90	5.15	319.0	1046.5	21.98	72.10
24.40	24.20	24.30	4.83	288.6	946.9	23.50	77.10
26.00	25.80	25.89	5.53	288.3	946.0	25.00	82.02
27.60	27.40	27.48	4.30	371.1	1217.6	26.60	87.27
29.00	28.80	28.88	3.00	464.7	1524.5	28.10	92.19
30.55	30.35	30.43	3.57	433.3	1421.5	29.57	97.03

Job No: 12-951 Client: GER Project Title: MCSFRC Yorktown Operator: TS-BK Hole: SCPTU-2 Site: MCSFRC Yorktown Date: 06:25:12 20:43
Oversite: 304:T1500F15U500



CBR EXCAVATION RECORD

CBR EXCAVATION RECORD

Project: **P984-P989 MCSFRC, Phase I**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Mid-Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER
GeoEnvironmental Resources, Inc.
Consulting Engineers

Photograph of Sample	Description
	CBR Testing Location: **P-1** Date Excavated: 6/22/2012 Notes:
	CBR Testing Location: **P-3** Date Excavated: 6/25/2012 Notes:
	CBR Testing Location: **P-8** Date Excavated: 6/25/2012 Notes: Bag Taken To Truck

CBR EXCAVATION RECORD

Project: **P984-P989 MCSFRC, Phase I**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Mid-Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER
GeoEnvironmental Resources, Inc.
Consulting Engineers

Photograph of Sample	Description
	CBR Testing Location: **P-9** Date Excavated: 6/22/2012 Notes:
	CBR Testing Location: **P-13** Date Excavated: 6/21/2012 Notes:
	CBR Testing Location: **P-14** Date Excavated: 6/21/2012 Notes:

CBR EXCAVATION RECORD

Project: **P984-P989 MCSFRC, Phase I**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Mid-Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER
GeoEnvironmental Resources, Inc.
Consulting Engineers

Photograph of Sample	Description
	CBR Testing Location: **P-18** Date Excavated: 6/20/2012 Notes: Image File Corrupted
	CBR Testing Location: Date Excavated: Notes:
	CBR Testing Location: Date Excavated: Notes:

FIELD PERMEABILITY TESTS

GER

MEASUREMENT OF FIELD SATURATED HYDRAULIC CONDUCTIVITY

Project: **MCSFRC Phase 1**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER Consulting Engineers
GeoEnvironmental Resources, Inc.

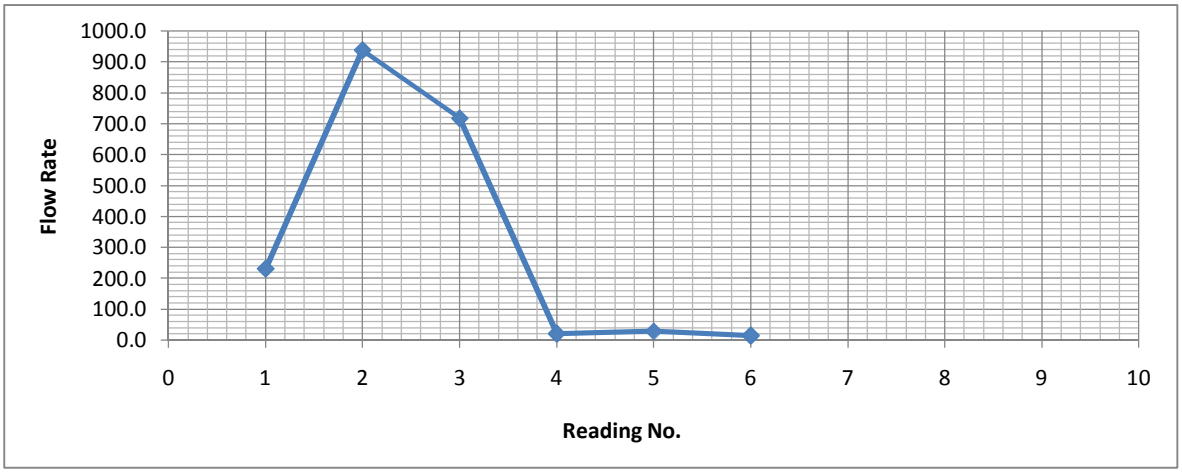
Boring/Test No: **P-1**

Setup Data

Test Date: 22-Jun-12
Investigator: CLC
Test Depth: 137.2 H (cm)
Depth to Water Table: 548.6 S (cm)
Borehole Diameter: 8.3 2r (cm)
Depth to Impermeable: N/A (cm)
Reservoir Height: 152.4 D (cm)
Reservoir Area: 81.1 A (cm^2)
Constant Head: 20.0 h (cm)
Water Temperature: 24 (^oC)
Soil Description: Clayey Sand (SC), fine to medium
Soil Alpha: 0.08

Field Readings

Reading No.	Time Actual (HH:mm:ss)	Reservoir Level (cm)	Reservoir Level (mL)	Time Interval (min)	Water Consumption (cm)	Water Consumption (mL)	Flow Rate (cm/min)	Flow Rate (mL/min)
0	9:27:00	45	2					
1	9:30:10	36	731	3.17	9	730	2.84	230.42
2	9:31:07	25	1623	0.95	11	892	11.58	938.74
3	9:32:08	16	2353	1.02	9	730	8.85	717.70
4	9:44:03	13	2596	11.92	3	243	0.25	20.41
5	9:55:43	9	2920	11.67	4	324	0.34	27.80
6	10:07:28	7	3082	11.75	2	162	0.17	13.80
7								
8								
9								
10								



Calculations

L = 431.5
L/h = 21.57
h/r = 4.85
C = 1.60
V_k/V_a = 1.00

Field Saturated Hydraulic Conductivity, K_{fsat}

by US Bureau of Reclamation, 1990
K_{fsat} = 0.008 cm/min
K_{fsat} = 0.19 in/hr

by Reynolds et al., 1993
K_{fsat} = 0.005 cm/min
K_{fsat} = 0.12 in/hr

AVG = **0.007** cm/min
0.15 in/hr

MEASUREMENT OF FIELD SATURATED HYDRAULIC CONDUCTIVITY

Project: **MCSFRC Phase 1**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER Consulting Engineers
GeoEnvironmental Resources, Inc.

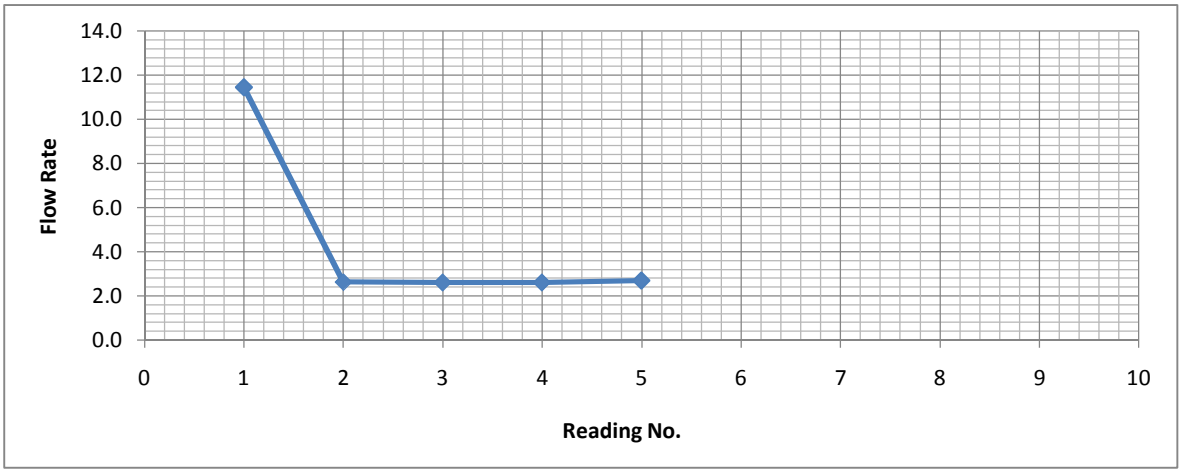
Boring/Test No: **P-6**

Setup Data

Test Date: 26-Jun-12
Investigator: CLC
Test Depth: 76.2 H (cm)
Depth to Water Table: 243.8 S (cm)
Borehole Diameter: 8.3 2r (cm)
Depth to Impermeable: N/A (cm)
Reservoir Height: 91.4 D (cm)
Reservoir Area: 81.1 A (cm^2)
Constant Head: 20.0 h (cm)
Water Temperature: 24 (^oC)
Soil Description: Clayey Sand (SC), fine to medium
Soil Alpha: 0.08

Field Readings

Reading No.	Time Actual (HH:mm:ss)	Reservoir Level (cm)	Reservoir Level (mL)	Time Interval (min)	Water Consumption (cm)	Water Consumption (mL)	Flow Rate (cm/min)	Flow Rate (mL/min)
0	14:10:00	37	650					
1	14:17:05	36	731	7.08	1	81	0.14	11.45
2	14:32:30	35.5	772	15.42	0.5	41	0.03	2.63
3	14:48:00	35	812	15.50	0.5	41	0.03	2.62
4	15:03:29	34.5	853	15.48	0.5	41	0.03	2.62
5	15:18:29	34	894	15.00	0.5	41	0.03	2.70
6								
7								
8								
9								
10								



Calculations

L = 187.6
L/h = 9.38
h/r = 4.85
C = 1.60
V_k/V_a = 1.00

Field Saturated Hydraulic Conductivity, K_{fsat}

by US Bureau of Reclamation, 1990
K_{fsat} = 0.002 cm/min
K_{fsat} = 0.04 in/hr

by Reynolds et al., 1993
K_{fsat} = 0.001 cm/min
K_{fsat} = 0.02 in/hr

AVG = **0.001** cm/min
0.03 in/hr

MEASUREMENT OF FIELD SATURATED HYDRAULIC CONDUCTIVITY

Project: **MCSFRC Phase 1**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER Consulting Engineers — GeoEnvironmental Resources, Inc.

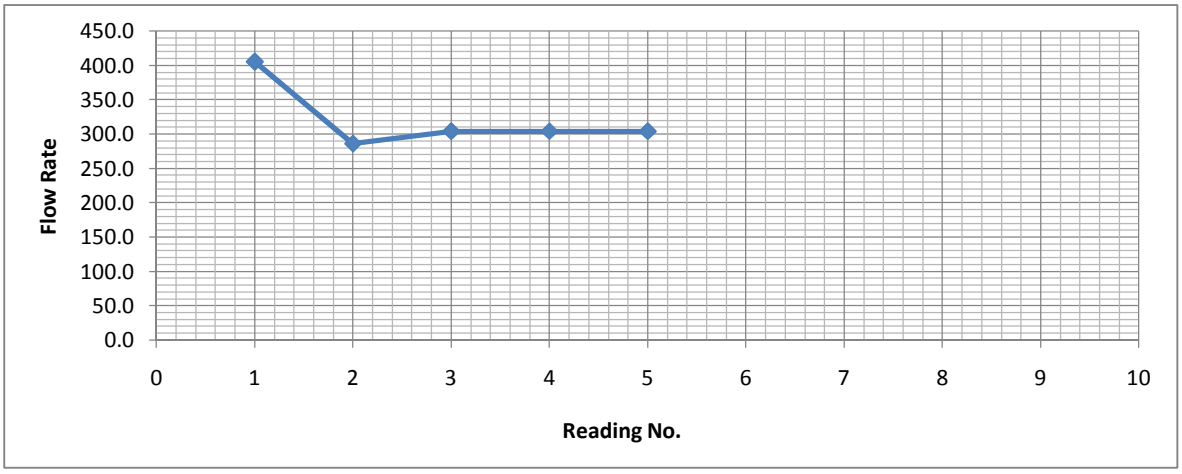
Boring/Test No: **P-8**

Setup Data

Test Date:	25-Jun-12		Investigator:	CLC	
Test Depth:	121.9	H (cm)	Depth to Water Table:	457.2	S (cm)
Borehole Diameter:	8.3	2r (cm)	Depth to Impermeable:	N/A	(cm)
Reservoir Height:	137.2	D (cm)	Reservoir Area:	81.1	A (cm^2)
Constant Head:	20.0	h (cm)	Water Temperature:	24	(^oC)
Soil Description:	Silty Sand (SM), fine to medium		Soil Alpha:	0.12	

Field Readings

Reading No.	Time Actual (HH:mm:ss)	Reservoir Level (cm)	Reservoir Level (mL)	Time Interval (min)	Water Consumption (cm)	Water Consumption (mL)	Flow Rate (cm/min)	Flow Rate (mL/min)
0	12:30:00	10	2839					
1	12:30:12	9	2920	0.20	1	81	5.00	405.37
2	12:30:29	8	3001	0.28	1	81	3.53	286.14
3	12:30:45	7	3082	0.27	1	81	3.75	304.02
4	12:31:01	6	3164	0.27	1	81	3.75	304.02
5	12:31:17	5	3245	0.27	1	81	3.75	304.02
6								
7								
8								
9								
10								



Calculations

L = 355.3
L/h = 17.76
h/r = 4.85
C = 1.60
V_k/V_a = 1.00

Field Saturated Hydraulic Conductivity, K_{fsat}

by US Bureau of Reclamation, 1990	K_{fsat} =	0.177	cm/min
	K_{fsat} =	4.19	in/hr
by Reynolds et al., 1993	K_{fsat} =	0.125	cm/min
	K_{fsat} =	2.94	in/hr
	AVG =	**0.151**	cm/min
		3.57	in/hr

MEASUREMENT OF FIELD SATURATED HYDRAULIC CONDUCTIVITY

Project: **MCSFRC Phase 1**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER Consulting Engineers
GeoEnvironmental Resources, Inc.

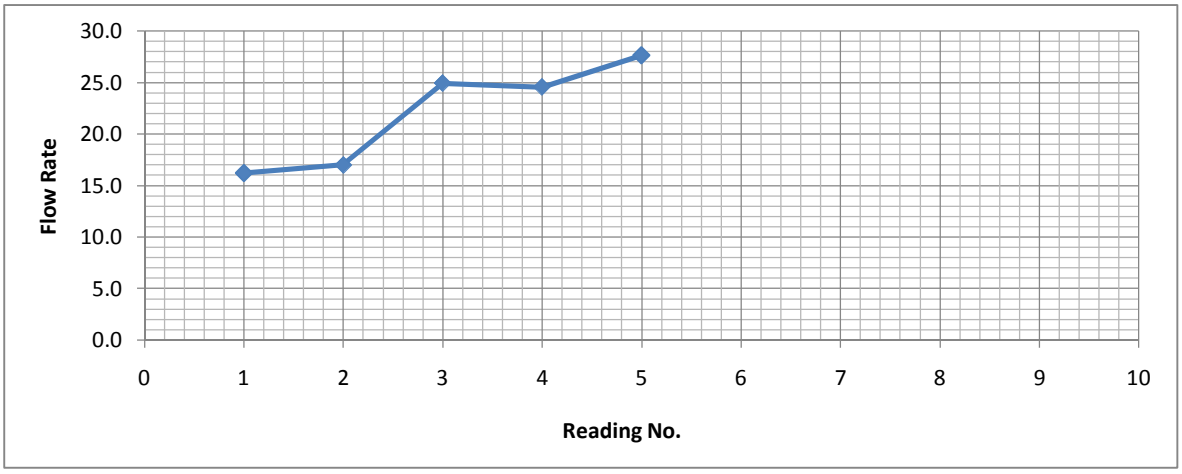
Boring/Test No: **P-9**

Setup Data

Test Date: 22-Jun-12
Investigator: CLC
Test Depth: 137.2 H (cm)
Depth to Water Table*: 609.6 S (cm)
* Water Table taken as bottom of boring
Borehole Diameter: 8.3 2r (cm)
Depth to Impermeable: N/A (cm)
Reservoir Height: 152.4 D (cm)
Reservoir Area: 81.1 A (cm^2)
Constant Head: 20.0 h (cm)
Water Temperature: 24 (^oC)
Soil Description: Low Plasticity Sandy Clay (CL)
Soil Alpha: 0.04

Field Readings

Reading No.	Time Actual (HH:mm:ss)	Reservoir Level (cm)	Reservoir Level (mL)	Time Interval (min)	Water Consumption (cm)	Water Consumption (mL)	Flow Rate (cm/min)	Flow Rate (mL/min)
0	12:04:00	13	2596					
1	12:09:00	12	2677	5.00	1	81	0.20	16.21
2	12:13:46	11	2758	4.77	1	81	0.21	17.01
3	12:17:01	10	2839	3.25	1	81	0.31	24.95
4	12:20:19	9	2920	3.30	1	81	0.30	24.57
5	12:23:15	8	3001	2.93	1	81	0.34	27.64
6								
7								
8								
9								
10								



Calculations

L = 492.4
L/h = 24.62
h/r = 4.85
C = 1.60
V_k/V_a = 1.00

Field Saturated Hydraulic Conductivity, K_{fsat}

by US Bureau of Reclamation, 1990
K_{fsat} = 0.014 cm/min
K_{fsat} = 0.34 in/hr

by Reynolds et al., 1993
K_{fsat} = 0.007 cm/min
K_{fsat} = 0.15 in/hr

AVG = **0.010** cm/min
0.25 in/hr

MEASUREMENT OF FIELD SATURATED HYDRAULIC CONDUCTIVITY

Project: **MCSFRC Phase 1**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene

GER Consulting Engineers
GeoEnvironmental Resources, Inc.

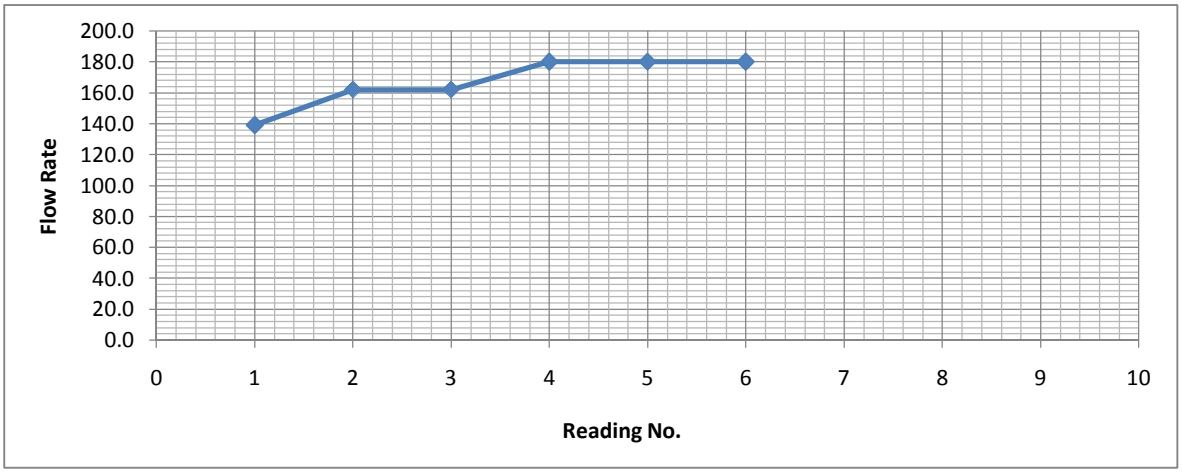
Boring/Test No: **P-15**

Setup Data

Test Date: 24-May-12
Investigator: CLC
Test Depth: 137.2 H (cm)
Depth to Water Table*: 609.6 S (cm)
* Water Table taken as bottom of boring
Borehole Diameter: 8.3 2r (cm)
Depth to Impermeable: N/A (cm)
Reservoir Height: 152.4 D (cm)
Reservoir Area: 81.1 A (cm^2)
Constant Head: 20.0 h (cm)
Water Temperature: 24 (^oC)
Soil Description: Silty Sand (SM), fine to medium
Soil Alpha: 0.12

Field Readings

Reading No.	Time Actual (HH:mm:ss)	Reservoir Level (cm)	Reservoir Level (mL)	Time Interval (min)	Water Consumption (cm)	Water Consumption (mL)	Flow Rate (cm/min)	Flow Rate (mL/min)
0	10:16:00	26	1542					
1	10:16:35	25	1623	0.58	1	81	1.71	138.98
2	10:17:05	24	1704	0.50	1	81	2.00	162.15
3	10:17:35	23	1785	0.50	1	81	2.00	162.15
4	10:18:02	22	1866	0.45	1	81	2.22	180.16
5	10:18:29	21	1947	0.45	1	81	2.22	180.16
6	10:18:56	20	2029	0.45	1	81	2.22	180.16
7								
8								
9								
10								



Calculations

L = 492.4
L/h = 24.62
h/r = 4.85
C = 1.60
V_k/V_a = 1.00

Field Saturated Hydraulic Conductivity, K_{fsat}

by US Bureau of Reclamation, 1990
K_{fsat} = 0.095 cm/min
K_{fsat} = 2.24 in/hr

by Reynolds et al., 1993
K_{fsat} = 0.066 cm/min
K_{fsat} = 1.57 in/hr

AVG = **0.081** cm/min
1.90 in/hr

MEASUREMENT OF FIELD SATURATED HYDRAULIC CONDUCTIVITY

Project: **MCSFRC Phase 1**
Location: **NWS Yorktown, VA**
GER Project #: **110-5960**
Client: **NAVFAC Atlantic**
Contract #: **N62470-12-D-2003, CTO WE09**

GER Consulting Engineers
Environmental
Groundwater
Hazardous Materials
Geotechnical
Industrial Hygiene
GeoEnvironmental Resources, Inc.

Boring/Test No: **P-18**

Setup Data

Test Date: 20-Jun-12 Investigator: CLC

Test Depth: 106.7 H (cm) Depth to Water Table: 213.4 S (cm)

Borehole Diameter: 8.3 2r (cm) Depth to Impermeable: N/A (cm)

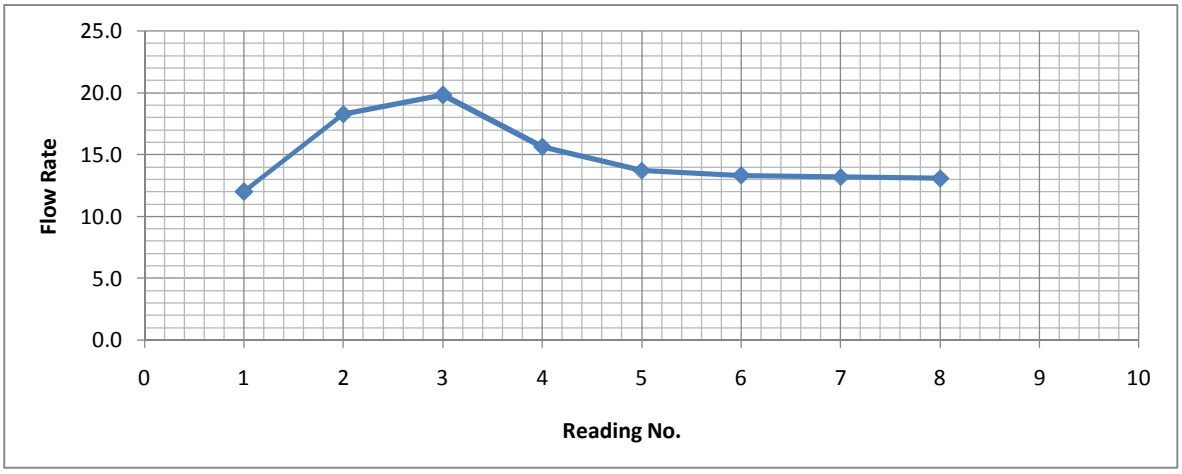
Reservoir Height: 121.9 D (cm) Reservoir Area: 81.1 A (cm^2)

Constant Head: 20.0 h (cm) Water Temperature: 24 (^oC)

Soil Description: Silty Sand (SM), fine to medium, with trace clay Soil Alpha: 0.12

Field Readings

Reading No.	Time Actual (HH:mm:ss)	Reservoir Level (cm)	Reservoir Level (mL)	Time Interval (min)	Water Consumption (cm)	Water Consumption (mL)	Flow Rate (cm/min)	Flow Rate (mL/min)
0	13:48:00	29	1299					
1	13:54:45	28	1380	6.75	1	81	0.15	12.01
2	13:59:11	27	1461	4.43	1	81	0.23	18.29
3	14:03:16	26	1542	4.08	1	81	0.24	19.85
4	14:08:27	25	1623	5.18	1	81	0.19	15.64
5	14:14:22	24	1704	5.92	1	81	0.17	13.70
6	14:20:27	23	1785	6.08	1	81	0.16	13.33
7	14:26:36	22	1866	6.15	1	81	0.16	13.18
8	14:32:48	21	1947	6.20	1	81	0.16	13.08
9								
10								



Calculations

Field Saturated Hydraulic Conductivity, K_{fsat}

L = 126.7
L/h = 6.33
h/r = 4.85
C = 1.60
V_k/V_a = 1.00

by US Bureau of Reclamation, 1990	K_{fsat} =	0.008	cm/min
	K_{fsat} =	0.18	in/hr
by Reynolds et al., 1993	K_{fsat} =	0.005	cm/min
	K_{fsat} =	0.13	in/hr
	AVG =	**0.006**	cm/min
		0.15	in/hr

APPENDIX C

LABORATORY TEST DATA

LABORATORY DATA SUMMARY

Project: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**

Number: **5336-110**
Date: **07/17/12**

SAMPLE NUMBER	DEPTH (FEET)	SAMPLE TYPE	CLASS.	MOISTURE CONTENT (%)	% FINES	LL	PL	PI	OTHER TESTS
B-1	5	SS	SC	-	40.7	-	-	-	SIEVE
B-1	17	SS	CH	48.2	-	54	23	31	-
B-2	14	SS	SP-SM	-	10.7	-	-	-	SIEVE
B-2	24	SS	CH	67.4	-	76	32	44	-
B-3	29	SS	SM	-	15.1	-	-	-	SIEVE
B-4	3	SS	CH	26.1	-	52	22	30	-
B-4	14	SS	CH	38.8	-	62	22	40	-
B-4	19	SS	CH	64.7	-	72	30	42	-
B-5	3	SS	ML	-	56.9	-	-	-	SIEVE
B-5	14	SS	SM	-	13.3	-	-	-	SIEVE
B-5	19	SS	CH	60.8	-	67	22	45	-
B-6	5	SS	CH	22.4	-	64	24	40	-
B-6	14	SS	CH	28.2	-	55	21	34	-
B-6	24	SS	SP-SM	-	9.2	-	-	-	SIEVE
B-7	3	SS	SC	-	48.8	-	-	-	SIEVE

Tests performed in accordance with applicable ASTM Standards**.**

etc.

LABORATORY DATA SUMMARY

Project: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**

Number: **5336-110**
Date: **07/17/12**

SAMPLE NUMBER	DEPTH (FEET)	SAMPLE TYPE	CLASS.	MOISTURE CONTENT (%)	% FINES	LL	PL	PI	OTHER TESTS
B-7	9	SS	SC	-	29.9	-	-	-	SIEVE
B-8	5	SS	CL	18.6	-	31	14	17	-
B-8	34	SS	CH	38.9	-	59	28	31	-
B-8	39	SS	CL	31.4	-	38	20	18	-
B-9	9	SS	CL	24.5	-	49	24	25	-
B-9	19	SS	SC	-	33.0	-	-	-	SIEVE
B-10	14	SS	SC	-	26.5	-	-	-	SIEVE
B-10	24	SS	CH	29.7	-	55	23	32	-
B-10	34	SS	SM	-	22.4	-	-	-	SIEVE
B-10	39	SS	CH	37.3	-	51	27	24	-
B-11	5	SS	SC	-	36.5	-	-	-	SIEVE
B-11	9	SS	SC	-	24.4	-	-	-	SIEVE
B-11	19	SS	MH	36.9	-	58	36	22	-
B-11	39	SS	CH	46.0	-	59	24	35	-

Tests performed in accordance with applicable ASTM Standards**.**

etc.

LABORATORY DATA SUMMARY

Project: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**

Number: **5336-110**
Date: **07/17/12**

SAMPLE NUMBER	DEPTH (FEET)	SAMPLE TYPE	CLASS.	MOISTURE CONTENT (%)	% FINES	LL	PL	PI	OTHER TESTS
P-1	1	SS	SC	-	44.1	-	-	-	SIEVE
P-1	7	SS	CL	19.7	-	44	21	23	-
P-2	3	SS	SC	-	36.6	-	-	-	SIEVE
P-2	14	SS	CH	34.0	-	57	23	34	-
P-3	3	SS	SM	-	32.1	-	-	-	SIEVE
P-3	11	SS	CH	32.4	-	54	24	30	-
P-4	3	SS	CH	23.3	-	60	26	34	-
P-5	11	SS	CH	35.7	-	56	24	32	-
P-6	3	SS	CL	-	67.8	-	-	-	SIEVE
P-6	14	SS	SC	-	31.2	-	-	-	SIEVE
P-7	3	SS	CL	-	61.4	-	-	-	SIEVE
P-7	24	SS	SM	-	30.3	-	-	-	SIEVE
P-8	1	SS	CL	-	57.7	-	-	-	SIEVE
P-8	7	SS	SM	-	14.3	-	-	-	SIEVE
P-9	3	SS	CL	15.7	-	30	22	8	-

Tests performed in accordance with applicable ASTM Standards**.**

etc.

LABORATORY DATA SUMMARY

Project: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**

Number: **5336-110**
Date: **07/17/12**

SAMPLE NUMBER	DEPTH (FEET)	SAMPLE TYPE	CLASS.	MOISTURE CONTENT (%)	% FINES	LL	PL	PI	OTHER TESTS
P-10	3	SS	SC	-	41.1	-	-	-	SIEVE
P-10	11	SS	SM	-	22.9	-	-	-	SIEVE
P-11	3	SS	CL	17.9	-	42	17	25	-
P-12	3	SS	CL	-	50.6	-	-	-	SIEVE
P-13	1	SS	SM	-	48.2	-	-	-	SIEVE
P-14	1	SS	CL	-	52.9	-	-	-	SIEVE
P-14	3	SS	CL	22.6	-	48	21	27	-
P-15	3	SS	CL	-	66.2	-	-	-	SIEVE
P-16	1	SS	CL	-	67.4	-	-	-	SIEVE
P-17	1	SS	CL	18.7	-	42	22	20	-
P-17	7	SS	CH	20.7	-	52	27	25	-
P-18	1	SS	CL	-	54.7	-	-	-	SIEVE
P-19	3	SS	CH	23.2	-	68	31	37	-
P-20	3	SS	CL	20.1	-	43	20	23	-
P-21	3	SS	CH	22.0	-	56	26	30	-

Tests performed in accordance with applicable ASTM Standards**.**

etc.

LABORATORY DATA SUMMARY

Project: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**

Number: **5336-110**
Date: **07/17/12**

SAMPLE NUMBER	DEPTH (FEET)	SAMPLE TYPE	CLASS.	MAXIMUM DRY DENSITY (PCF)	OPTIMUM MOISTURE (%)	CBR	SWELL (%)
P-1	1 to 2	Bulk	CL	108.7	16.7	4.5	0.5
P-3	1 to 2	Bulk	SM	115.8	13.7	1.4	0.2
P-8	1 to 2	Bulk	CL	114.8	14.7	4.8	0.4
P-9	1 to 2	Bulk	SM	116.8	13.7	3.5	0.1
P-13	1 to 2	Bulk	SM	105.0	16.7	3.0	0.3
P-14	1 to 2	Bulk	SM	112.2	11.9	2.0	0.0
P-18	1 to 2	Bulk	CL	113.0	15.5	4.9	0.4

Tests performed in accordance with applicable ASTM Standards**.**

etc.

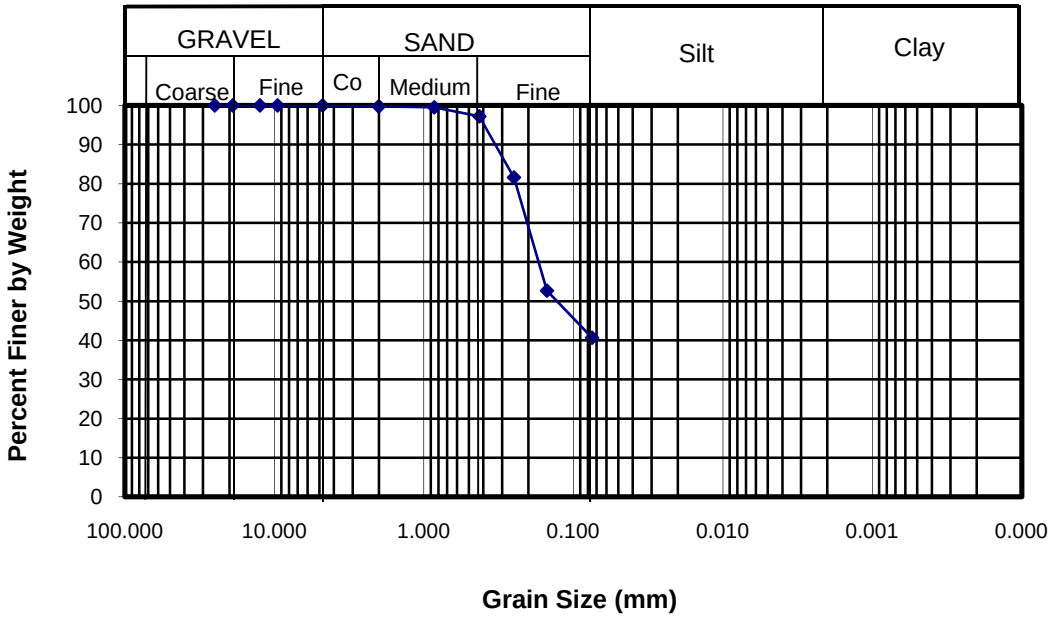
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-1
Sample Depth: 5 feet
Sample Description: Clayey SAND (SC), Tan-Orange, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.8
20	99.5
40	97.2
60	81.6
100	52.7
200	40.7



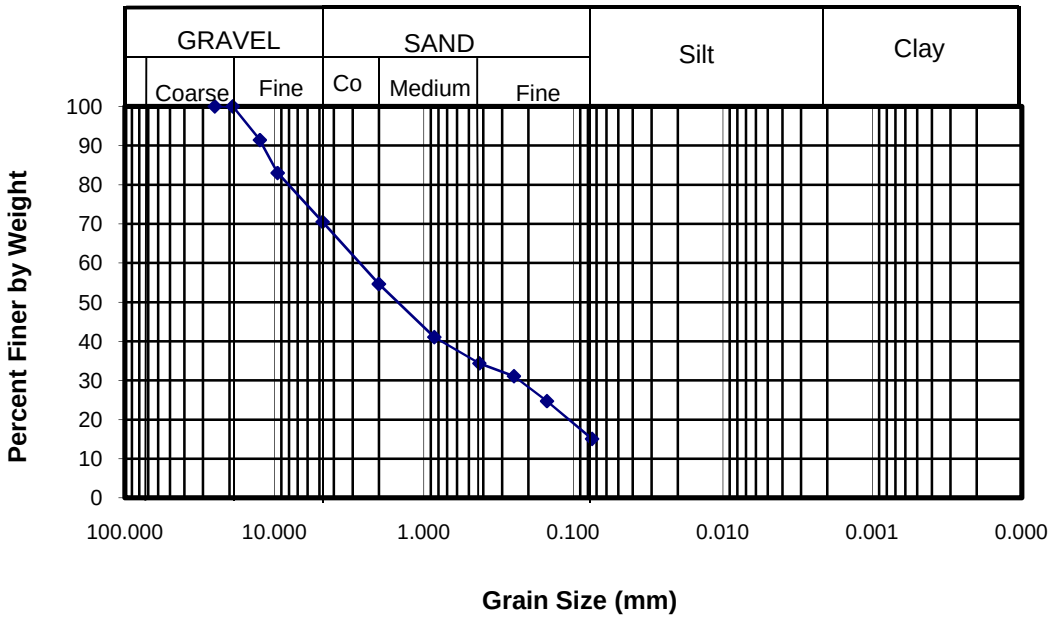
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-3
Sample Depth: 29 feet
Sample Description: Silty SAND (SM), Tan, Fine to Coarse, with Shell Fragments
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	91.4
3/8 Inch	83.0
4	70.5
10	54.6
20	41.1
40	34.4
60	31.1
100	24.7
200	15.1



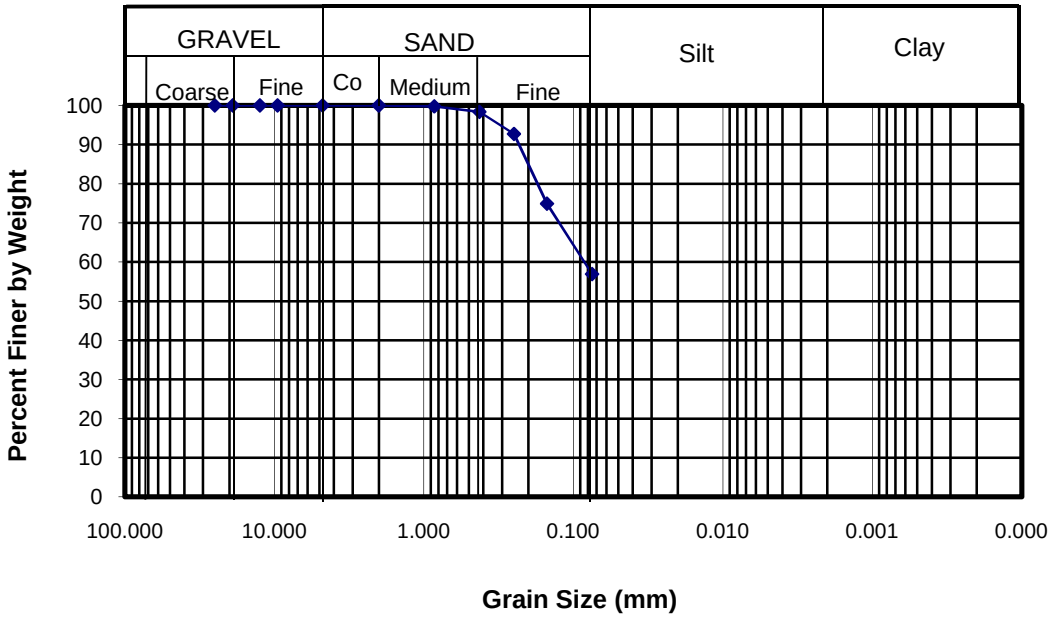
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-5
Sample Depth: 3 feet
Sample Description: Sandy SILT (ML), Tan
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.8
40	98.4
60	92.7
100	74.9
200	56.9



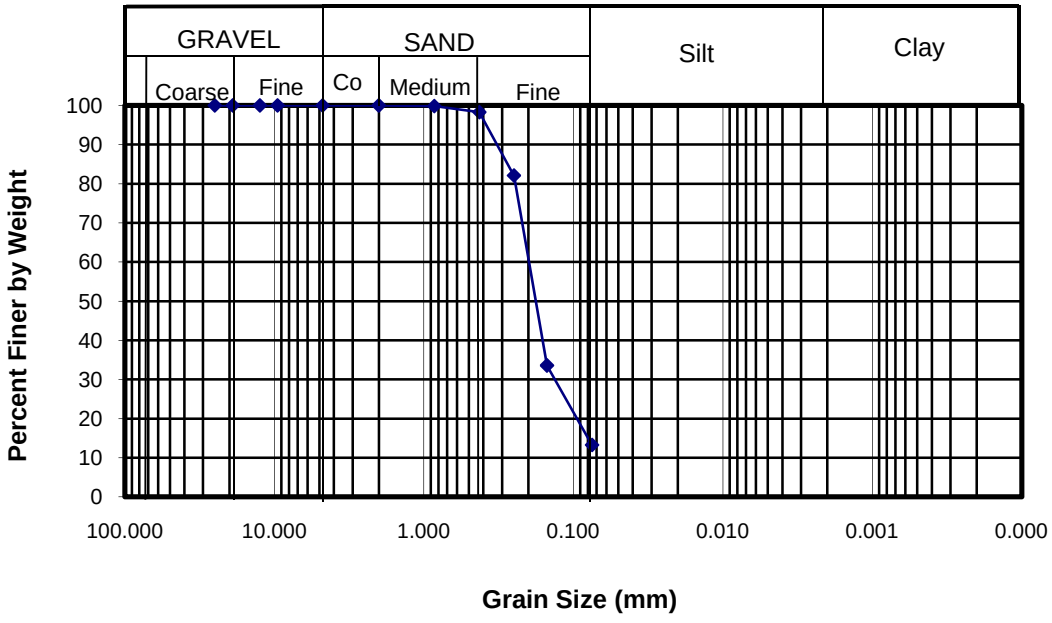
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-5
Sample Depth: 14 feet
Sample Description: Silty SAND (SM), Tan, Fine
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.8
40	98.3
60	82.1
100	33.6
200	13.3



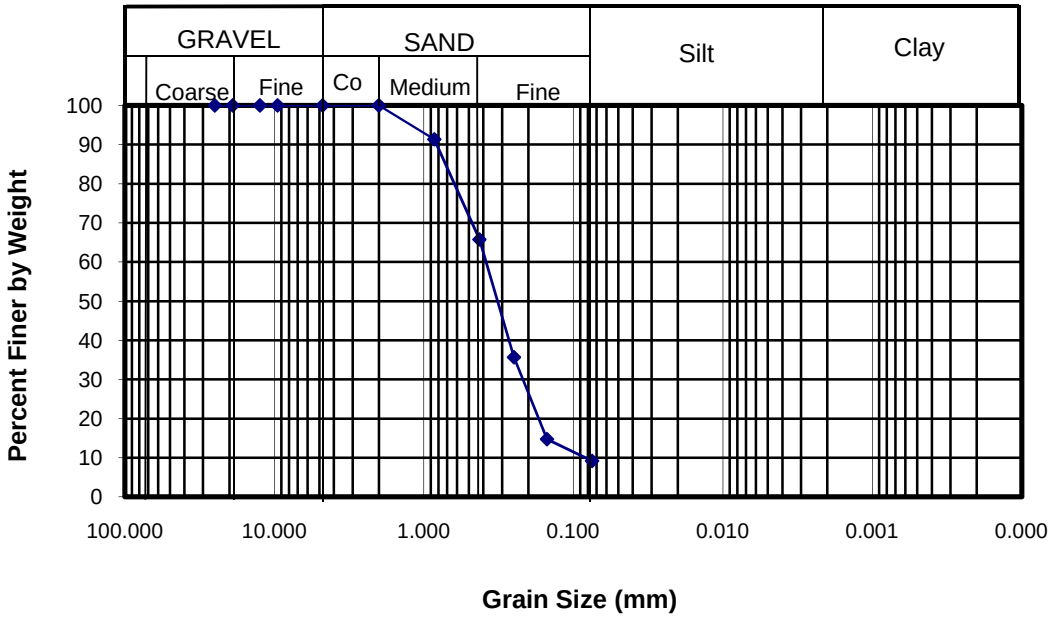
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-6
Sample Depth: 24 feet
Sample Description: SAND (SP-SM), Tan, Fine to Medium, Trace Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	91.4
40	65.8
60	35.7
100	14.8
200	9.2



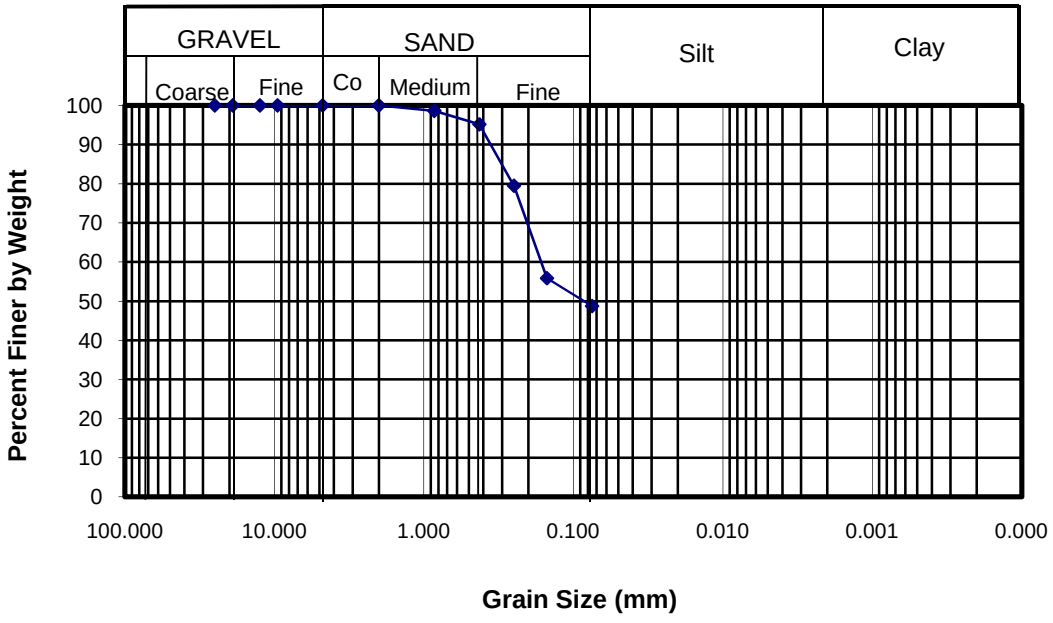
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-7
Sample Depth: 3 feet
Sample Description: Clayey SAND (SC), Tan and Red, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	98.6
40	95.1
60	79.5
100	55.9
200	48.8



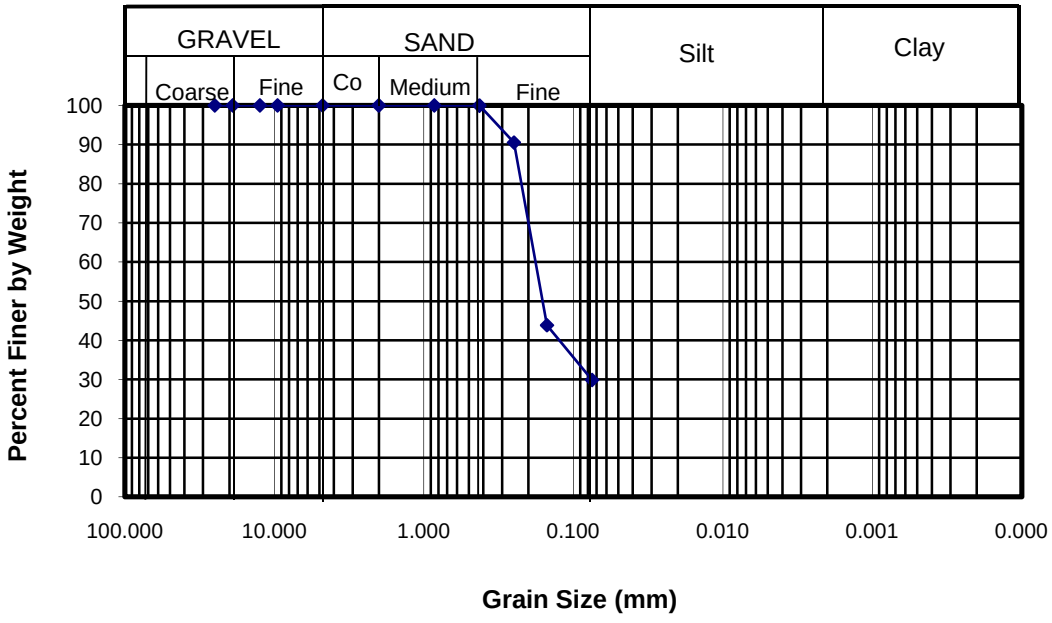
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-7
Sample Depth: 9 feet
Sample Description: Clayey SAND (SC), Tan-Orange, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	100.0
40	100.0
60	90.5
100	43.9
200	29.9



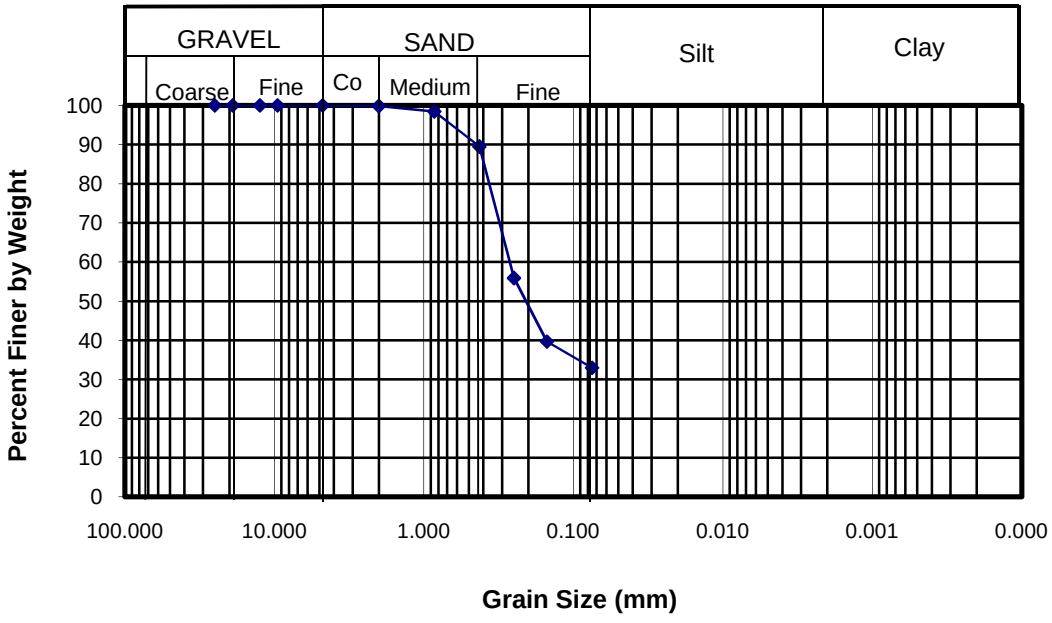
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-9
Sample Depth: 19 feet
Sample Description: Clayey SAND (SC), Tan, Fine to Medium, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.8
20	98.4
40	89.5
60	55.9
100	39.7
200	33.0



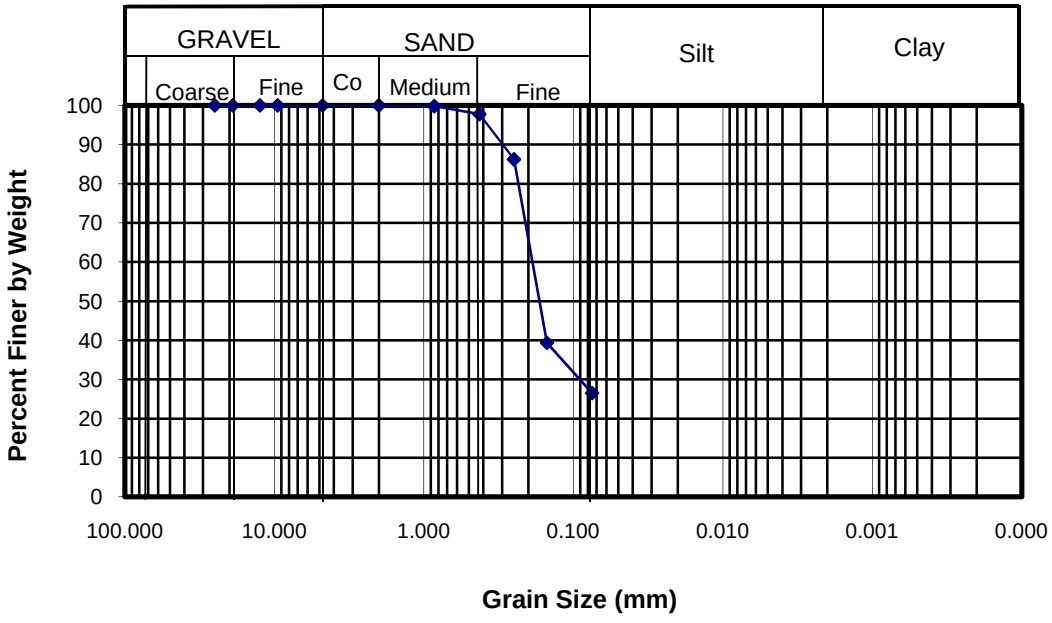
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-10
Sample Depth: 14 feet
Sample Description: Clayey SAND (SC), Tan-Orange, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.8
40	97.8
60	86.2
100	39.4
200	26.5



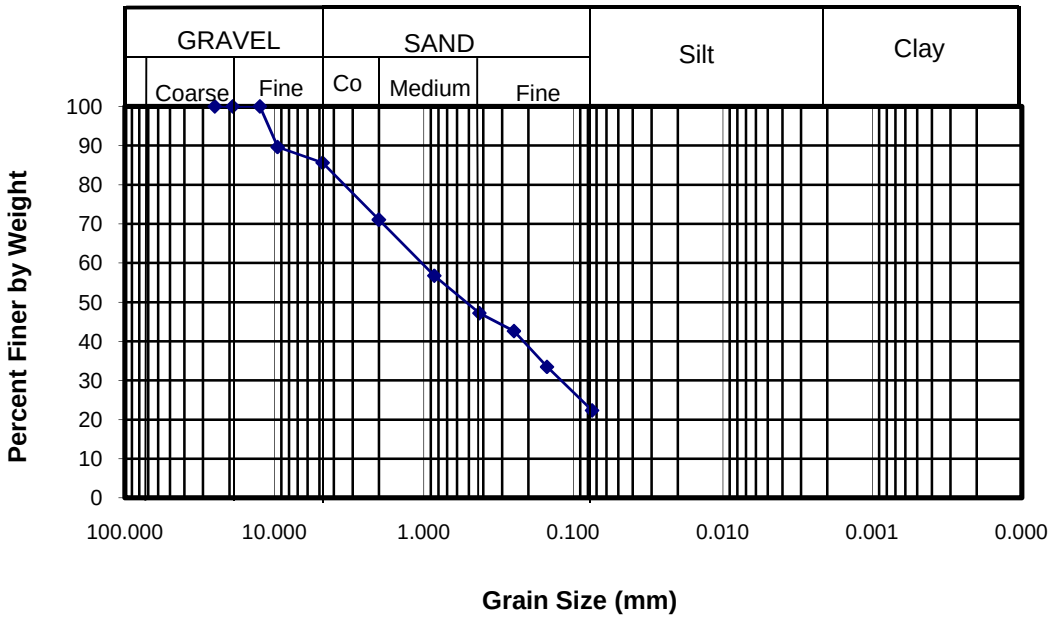
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-10
Sample Depth: 34 feet
Sample Description: Silty SAND (SM), Tan, Fine to Coarse, Trace Clay, with Shell Fragments
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	89.6
4	85.6
10	71.1
20	56.8
40	47.2
60	42.6
100	33.5
200	22.4



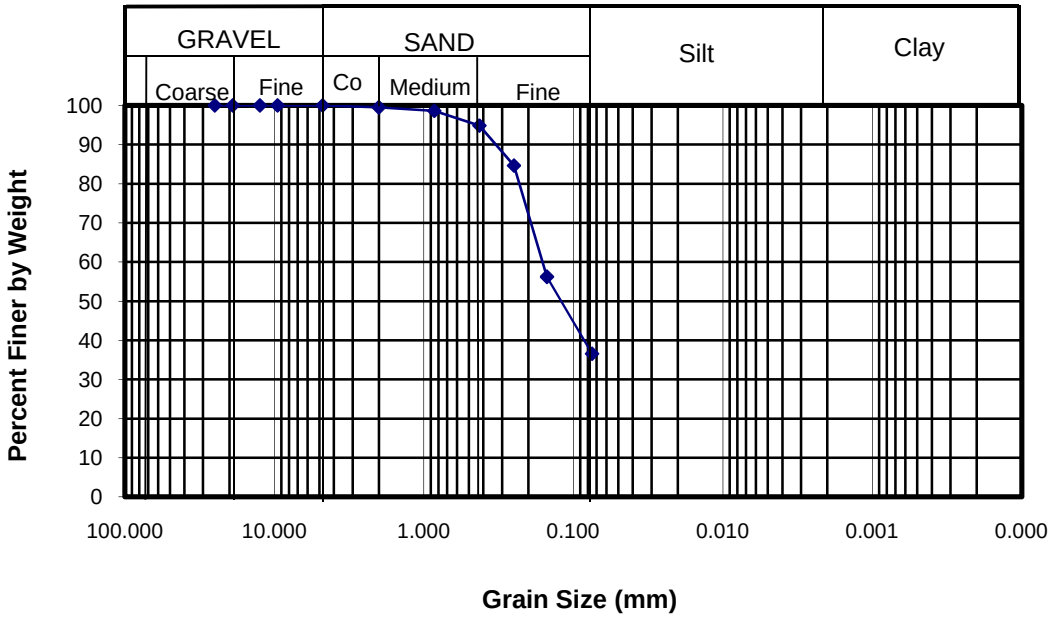
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-11
Sample Depth: 5 feet
Sample Description: Clayey SAND (SC), Tan, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.5
20	98.6
40	94.9
60	84.6
100	56.2
200	36.5



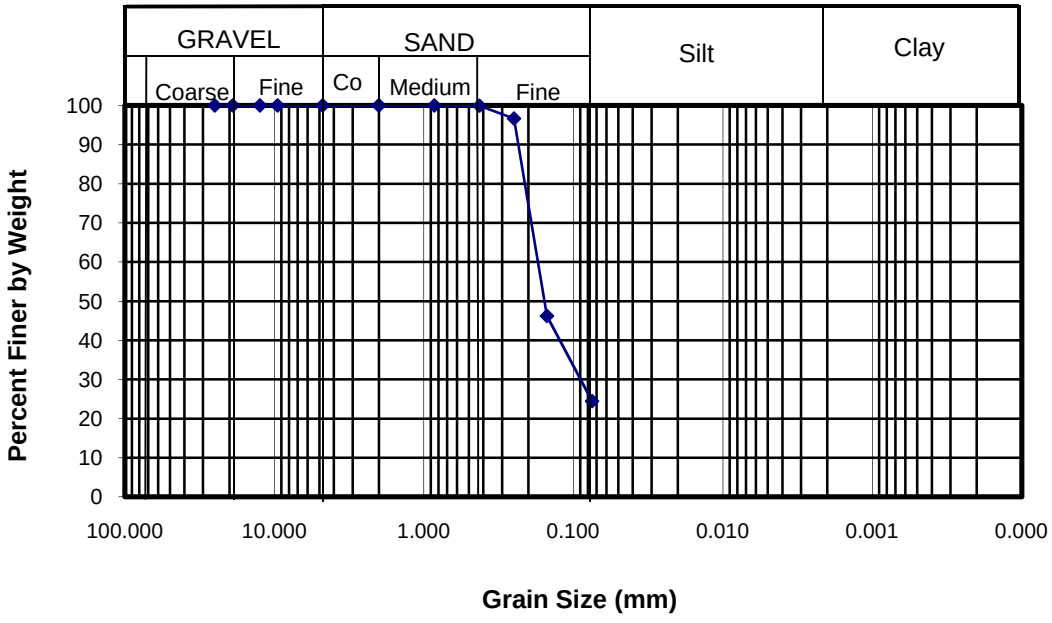
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: B-11
Sample Depth: 9 feet
Sample Description: Clayey SAND (SC), Orange, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	100.0
40	99.9
60	96.7
100	46.2
200	24.4



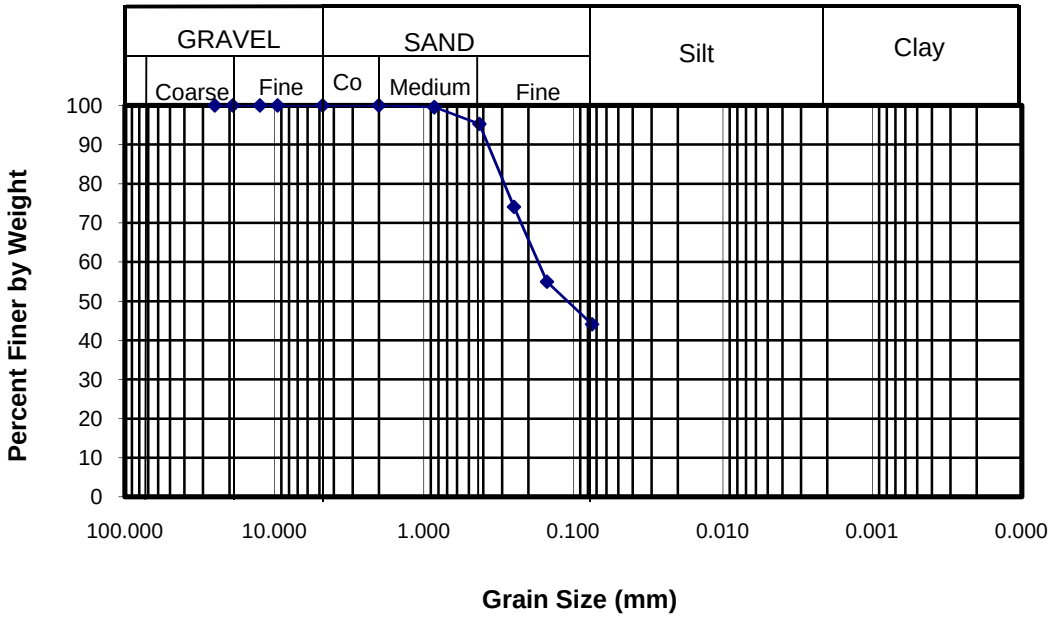
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-1
Sample Depth: 1 foot
Sample Description: Clayey SAND (SC), Tan, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.5
40	95.2
60	74.1
100	55.0
200	44.1



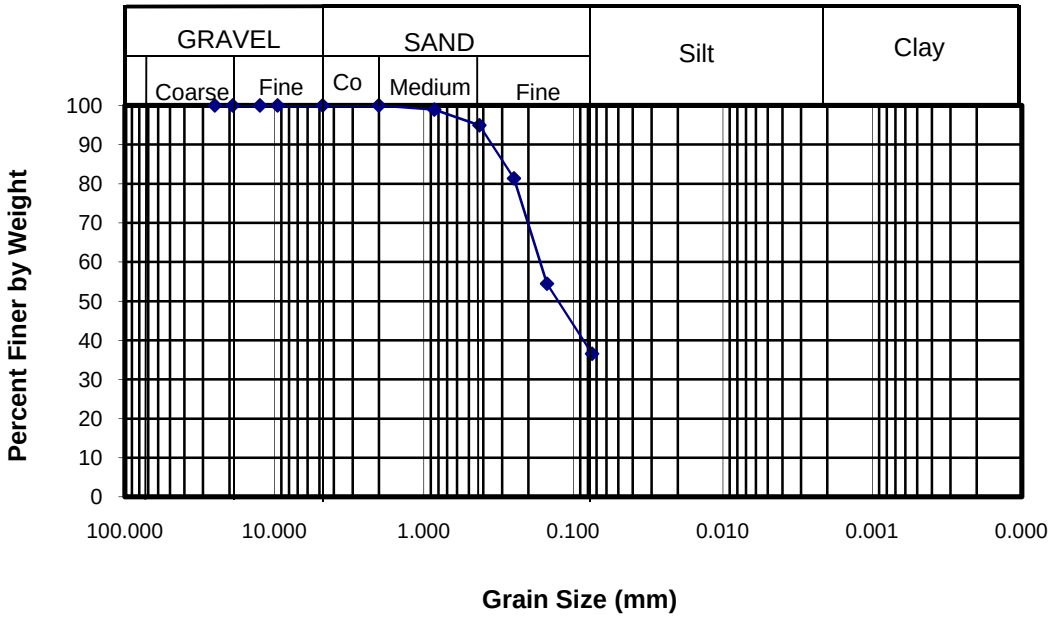
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-2
Sample Depth: 3 feet
Sample Description: Clayey SAND (SC), Tan-Orange, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.0
40	94.9
60	81.4
100	54.5
200	36.6



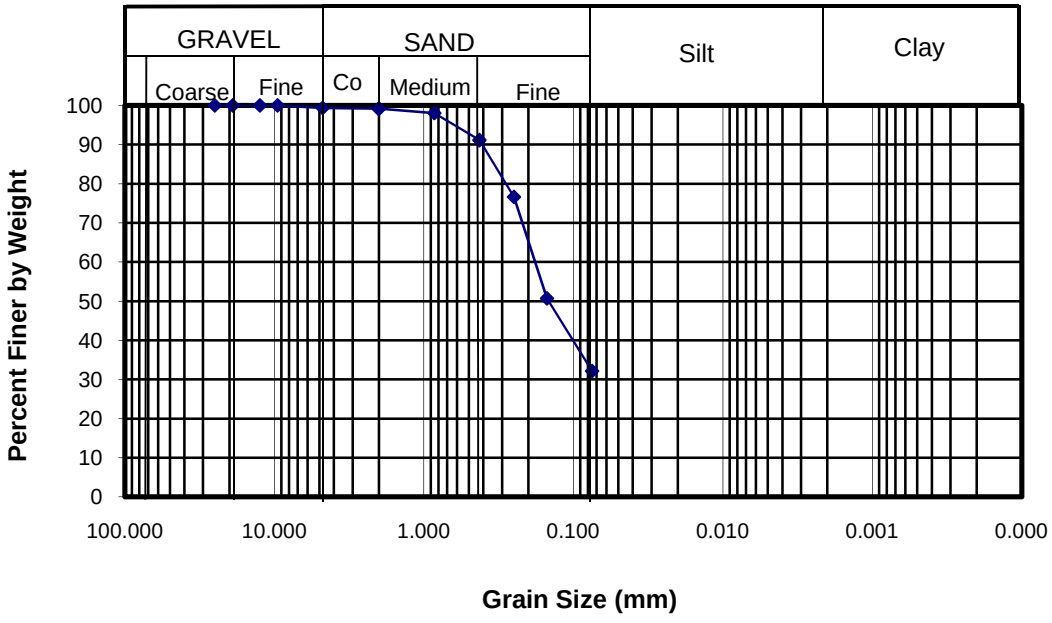
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-3
Sample Depth: 3 feet
Sample Description: Silty SAND (SM), Tan, Fine
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	99.4
10	99.1
20	98.0
40	91.1
60	76.6
100	50.7
200	32.1



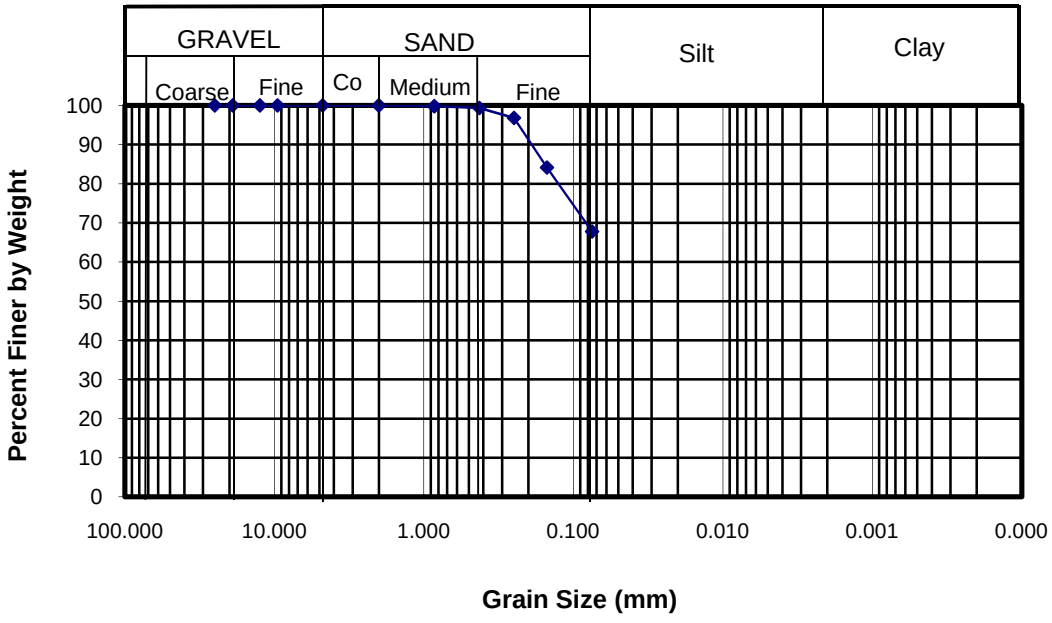
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-6
Sample Depth: 3 feet
Sample Description: Sandy CLAY (CL), Tan, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.8
40	99.3
60	96.8
100	84.2
200	67.8



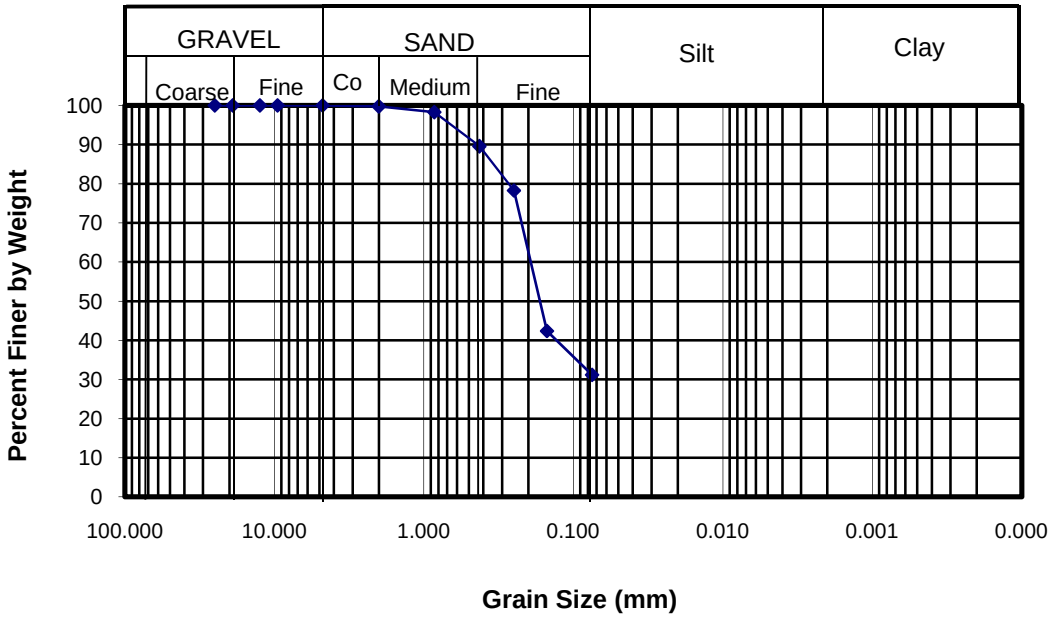
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-6
Sample Depth: 14 feet
Sample Description: Clayey SAND (SC), Orange, Fine to Medium, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.7
20	98.3
40	89.6
60	78.3
100	42.4
200	31.2



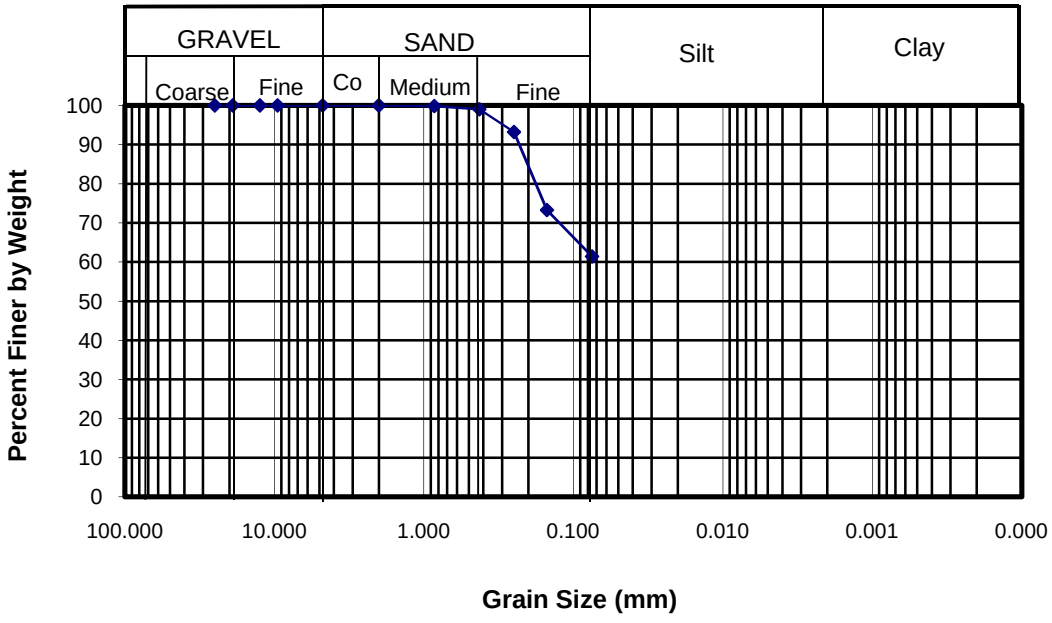
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-7
Sample Depth: 3 feet
Sample Description: Sandy CLAY (CL), Orange, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.8
40	99.0
60	93.2
100	73.3
200	61.4



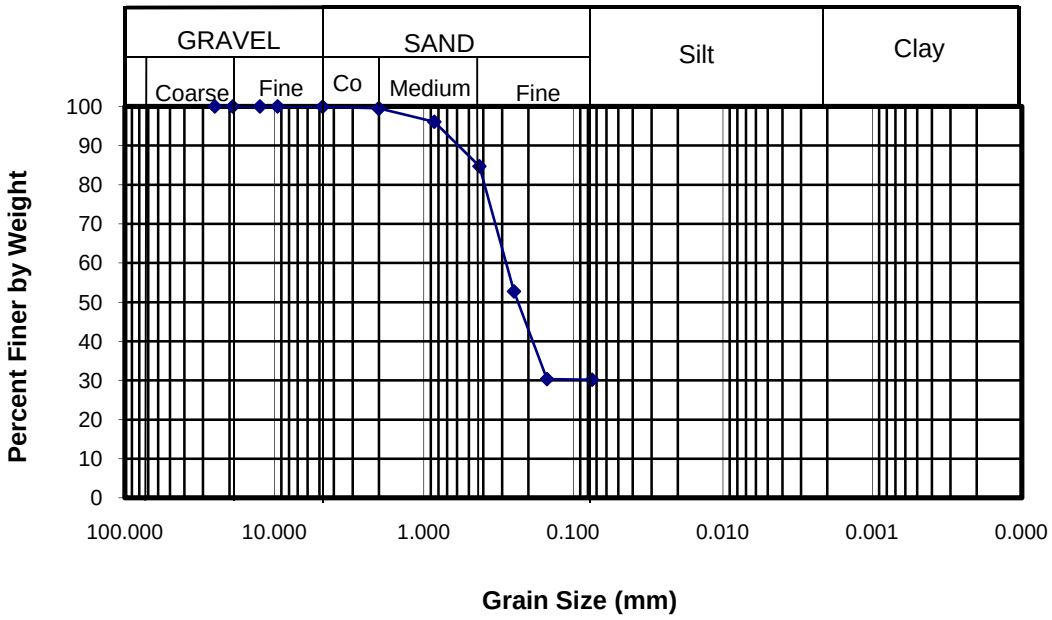
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-7
Sample Depth: 24 feet
Sample Description: Silty SAND (SM), Red-Orange, Fine to Medium, Trace Fine Gravel
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	99.9
10	99.5
20	96.1
40	84.7
60	52.7
100	30.3
200	30.2



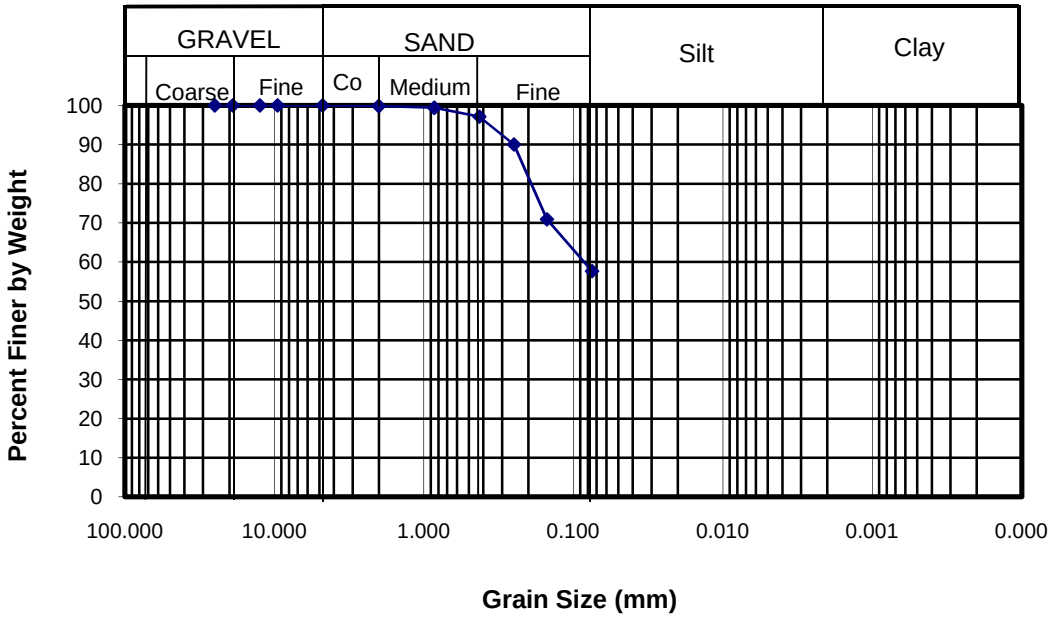
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-8
Sample Depth: 1 foot
Sample Description: Sandy CLAY (CL), Tan, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.9
20	99.4
40	97.2
60	90.0
100	70.9
200	57.7



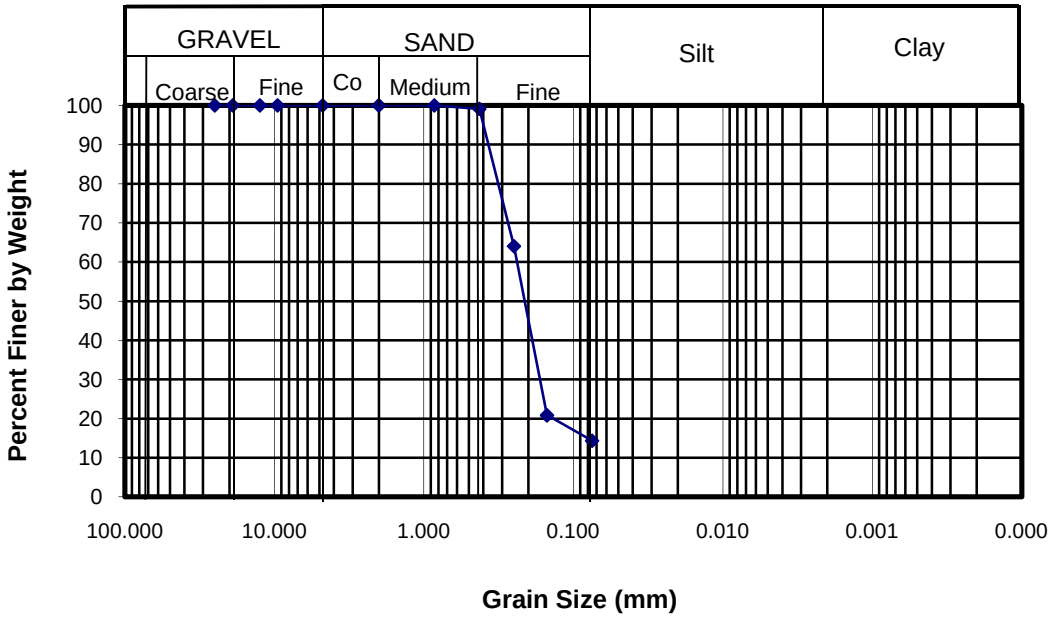
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-8
Sample Depth: 7 feet
Sample Description: Silty SAND (SM), Tan, Fine
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	100.0
40	99.1
60	64.0
100	20.8
200	14.3



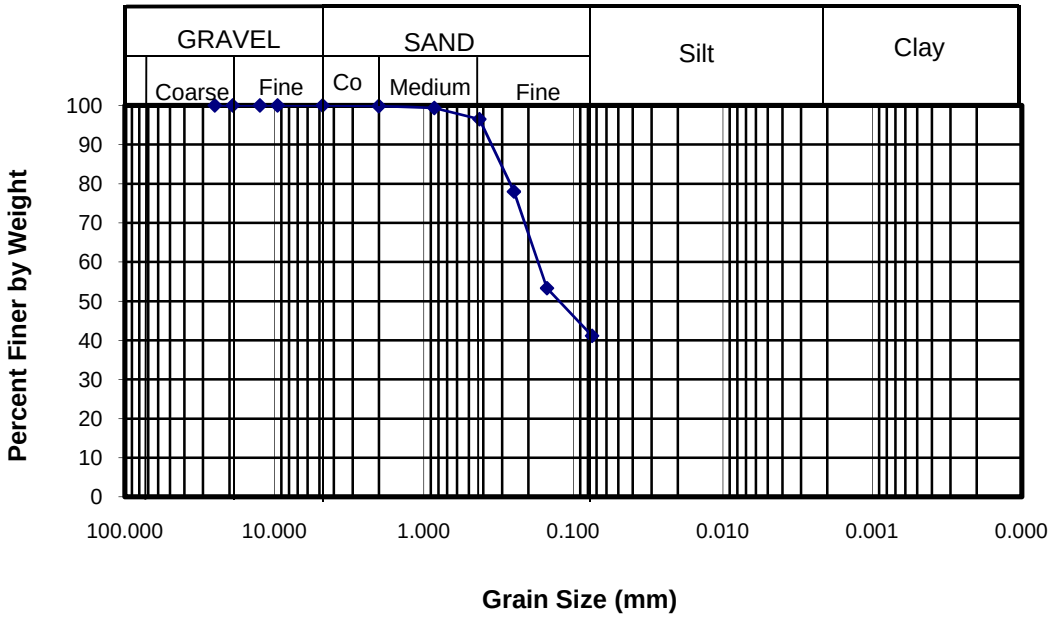
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-10
Sample Depth: 3 feet
Sample Description: Clayey SAND (SC), Tan, Fine, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.8
20	99.3
40	96.5
60	78.0
100	53.3
200	41.1



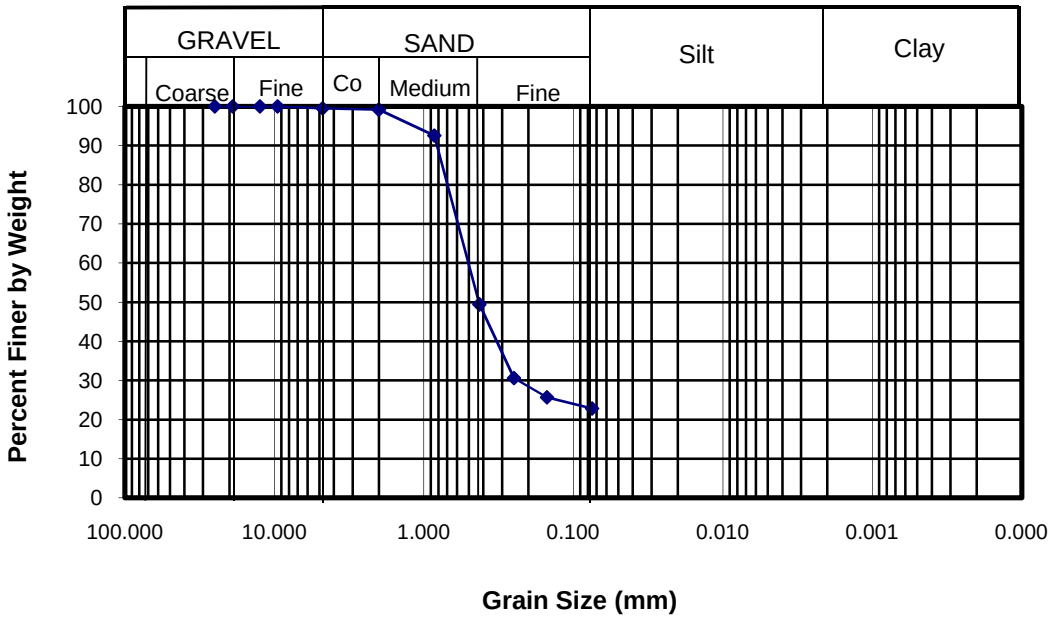
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-10
Sample Depth: 11 feet
Sample Description: Silty SAND (SM), Orange, Fine to Medium, with Clay, Trace Fine Gravel
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	99.5
10	99.2
20	92.6
40	49.5
60	30.6
100	25.7
200	22.9



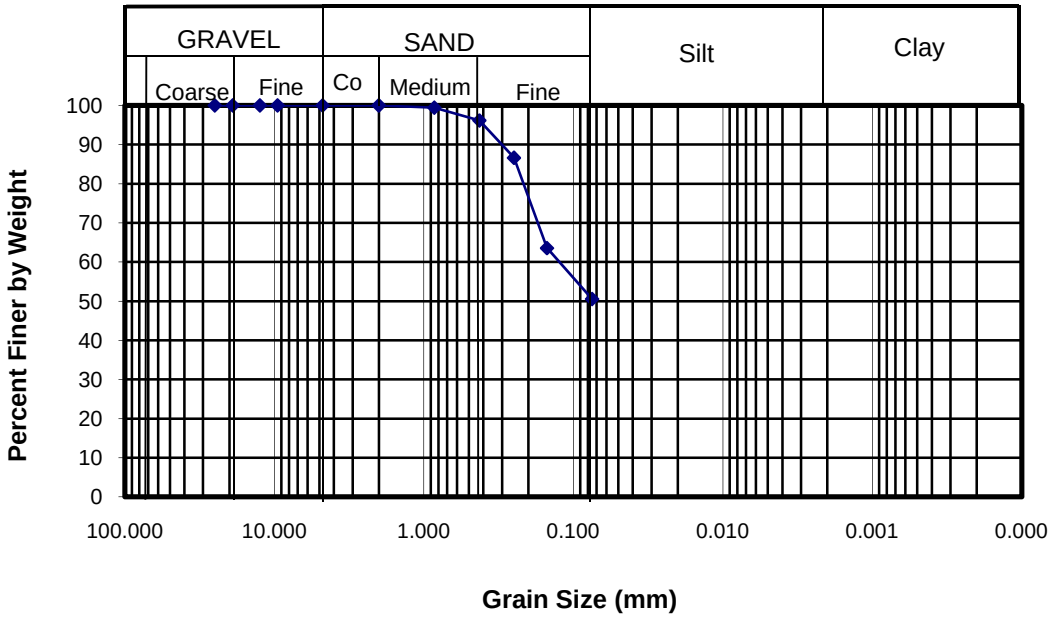
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-12
Sample Depth: 3 feet
Sample Description: Sandy CLAY (CL), Tan, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.4
40	96.2
60	86.6
100	63.6
200	50.6



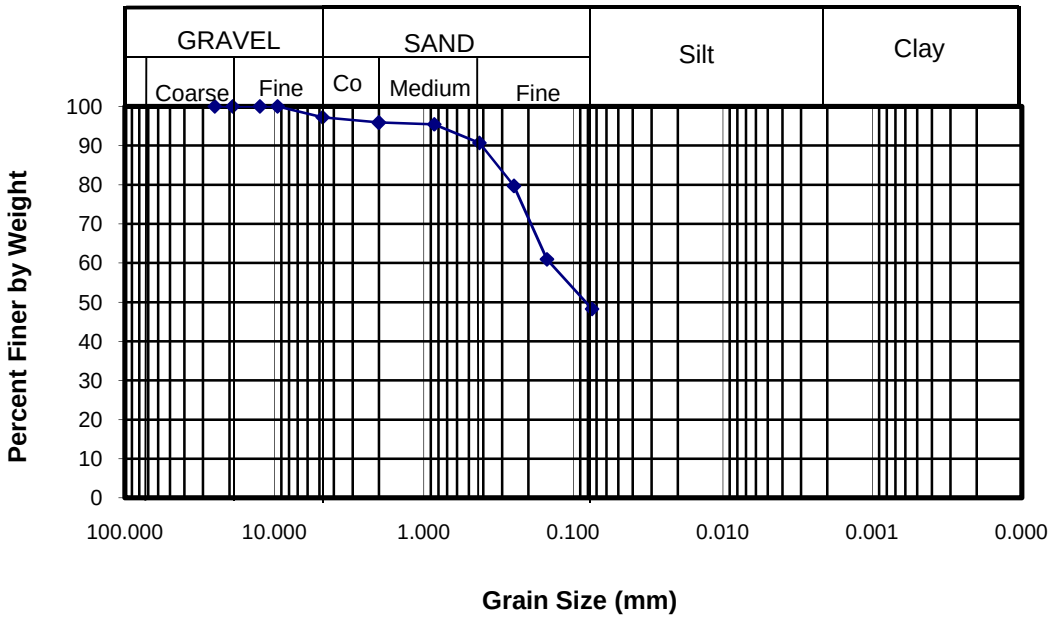
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-13
Sample Depth: 1 foot
Sample Description: Silty SAND (SM), Tan, Fine to Medium, Trace Fine Gravel
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	97.2
10	95.9
20	95.4
40	90.7
60	79.7
100	60.9
200	48.2



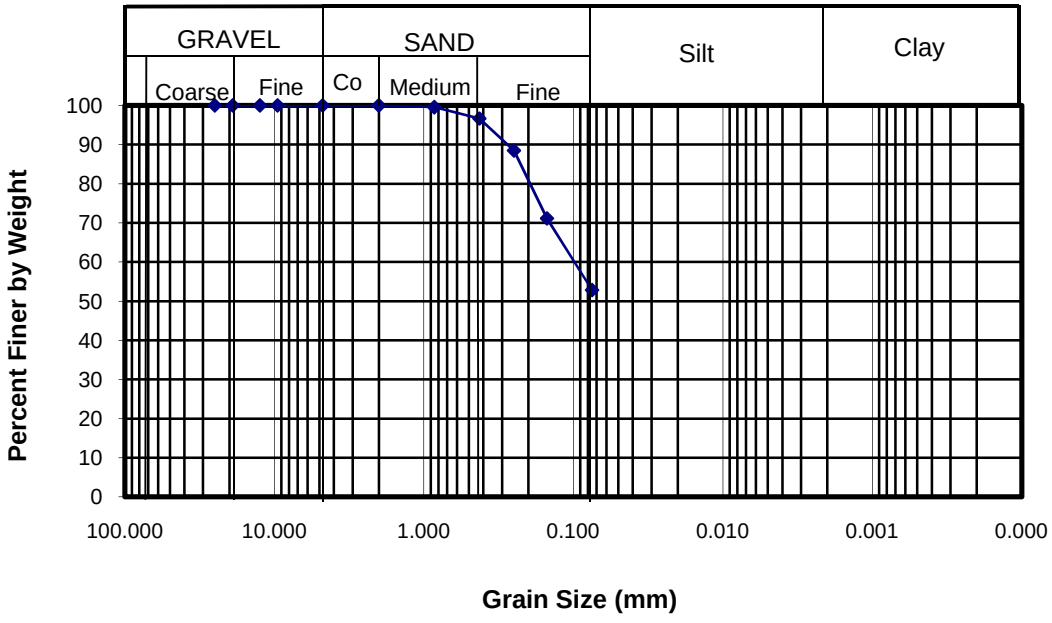
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-14
Sample Depth: 1 foot
Sample Description: Sandy CLAY (CL), Tan, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.6
40	96.6
60	88.5
100	71.1
200	52.9



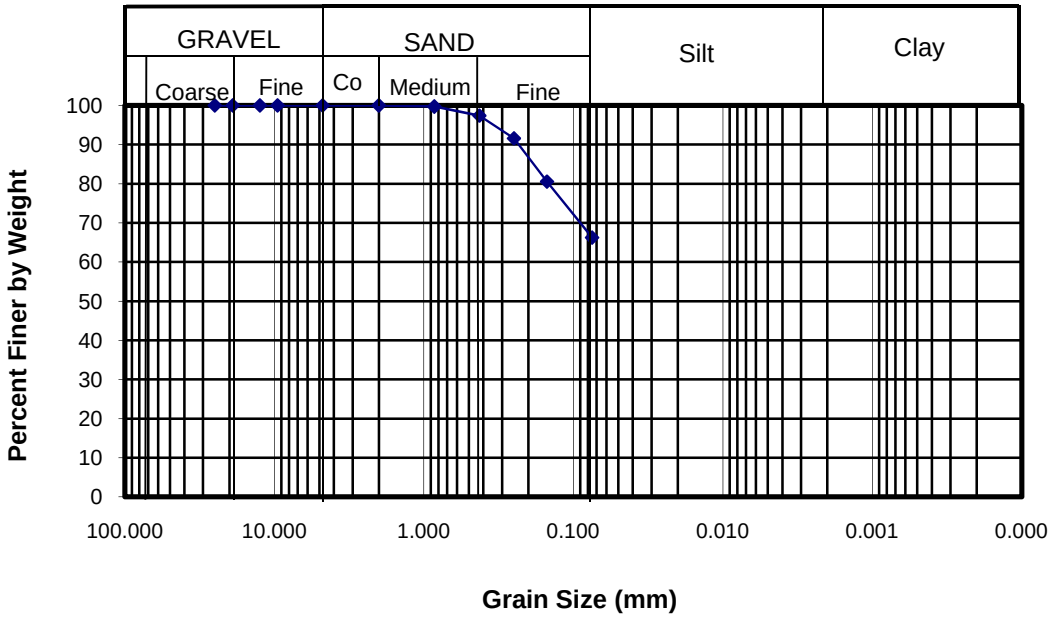
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-15
Sample Depth: 3 feet
Sample Description: Sandy CLAY (CL), Tan, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.7
40	97.4
60	91.6
100	80.5
200	66.2



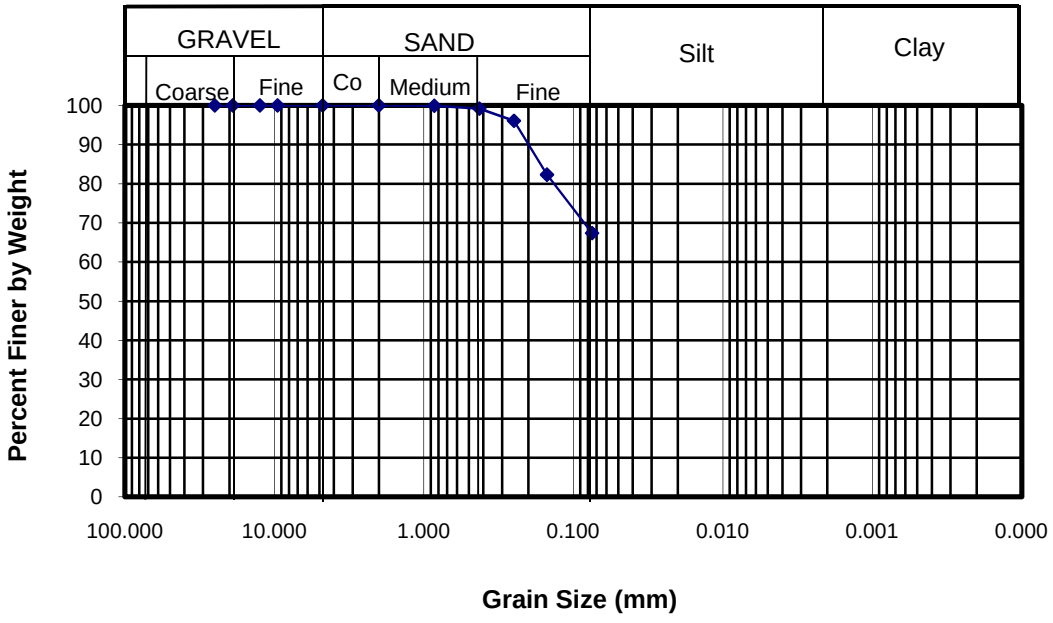
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-16
Sample Depth: 1 foot
Sample Description: Sandy CLAY (CL), Tan-Orange, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	100.0
20	99.9
40	99.2
60	96.1
100	82.3
200	67.4



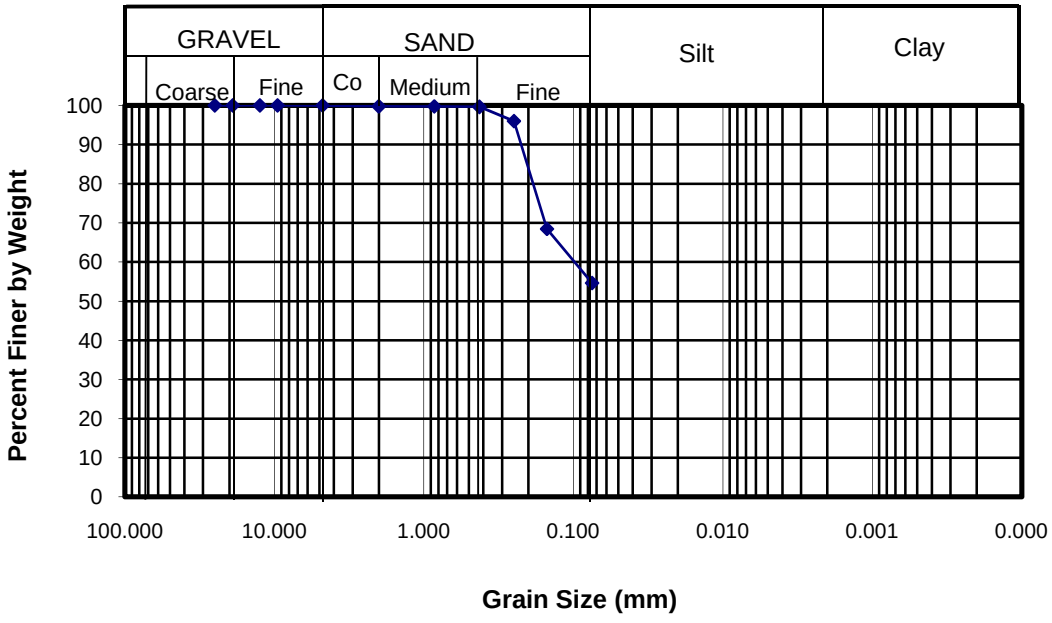
Engineering and Testing Consultants, Inc.

SIEVE ANALYSIS

Project Name: **P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number: **110-5960**
Project Number: 5336-110
Sample Number: P-18
Sample Depth: 1 foot
Sample Description: Sandy CLAY (CL), Tan-Orange, with Silt
Test Method: ASTM D 422

Sieve Analysis Data

SIEVE NO.	PERCENT PASSING
1 Inch	100.0
3/4 Inch	100.0
1/2 Inch	100.0
3/8 Inch	100.0
4	100.0
10	99.8
20	99.7
40	99.6
60	96.0
100	68.5
200	54.7

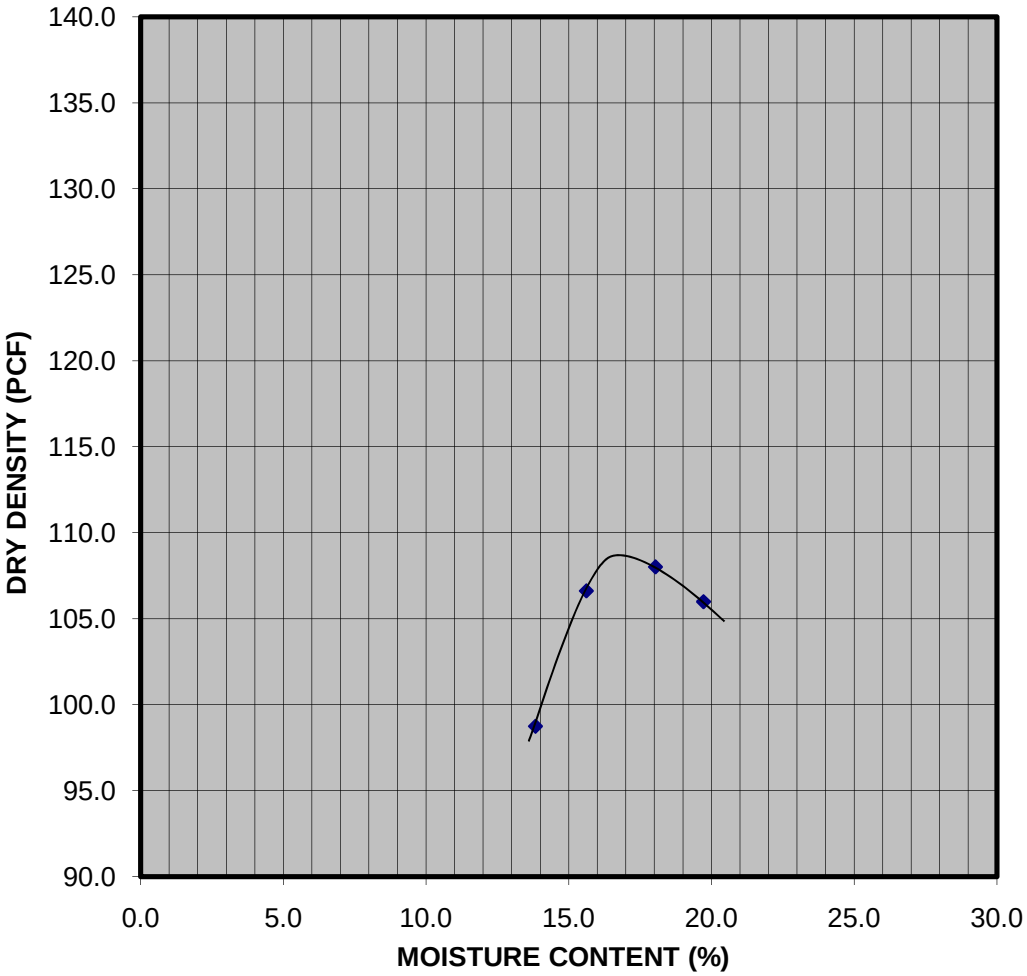


Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-1**
Sample Depth:	1 to 2 feet
Sample Description:	Sandy CLAY (CL), Tan, with Silt
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 108.7
Optimum Moisture (%): 16.7



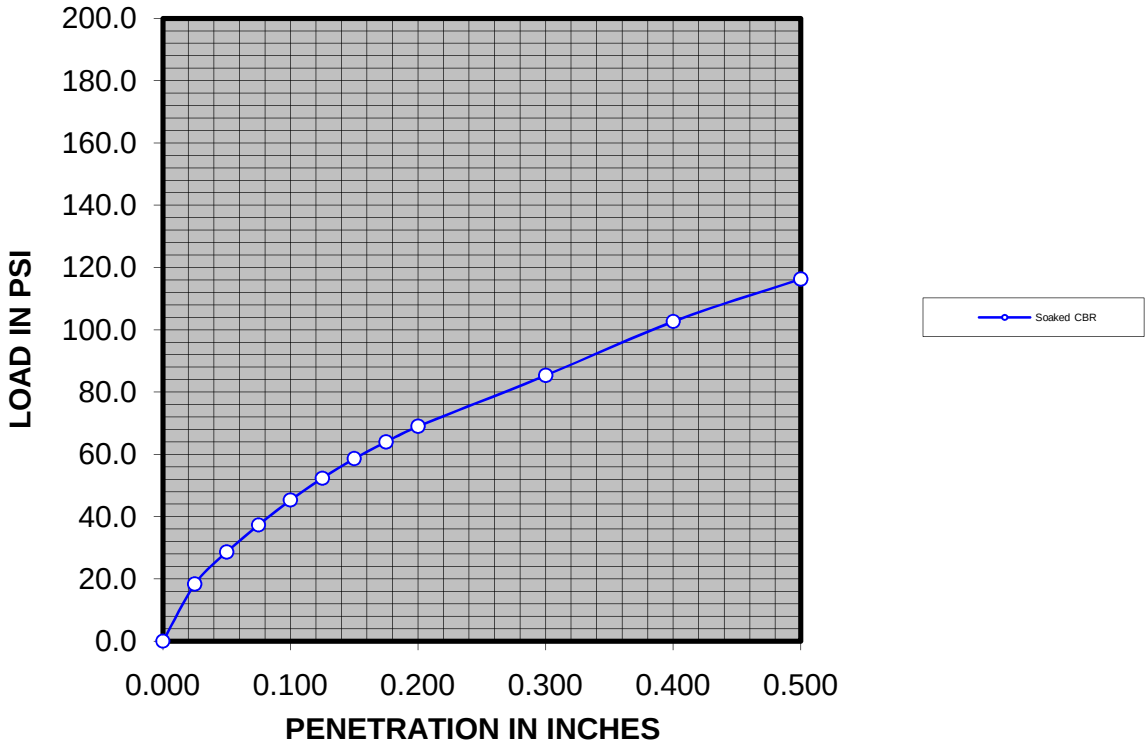
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-1**
Sample Depth:	1 to 2 feet
Sample Description:	Sandy CLAY (CL), Tan, with Silt
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	108.7	Blows Per Layer:	37
Optimum Moisture (%):	16.7	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	96.3
After Soaking Moisture (%):	19.1	Compaction After Soaking (%):	95.9

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**4.5**
Swell (%):	**0.5**

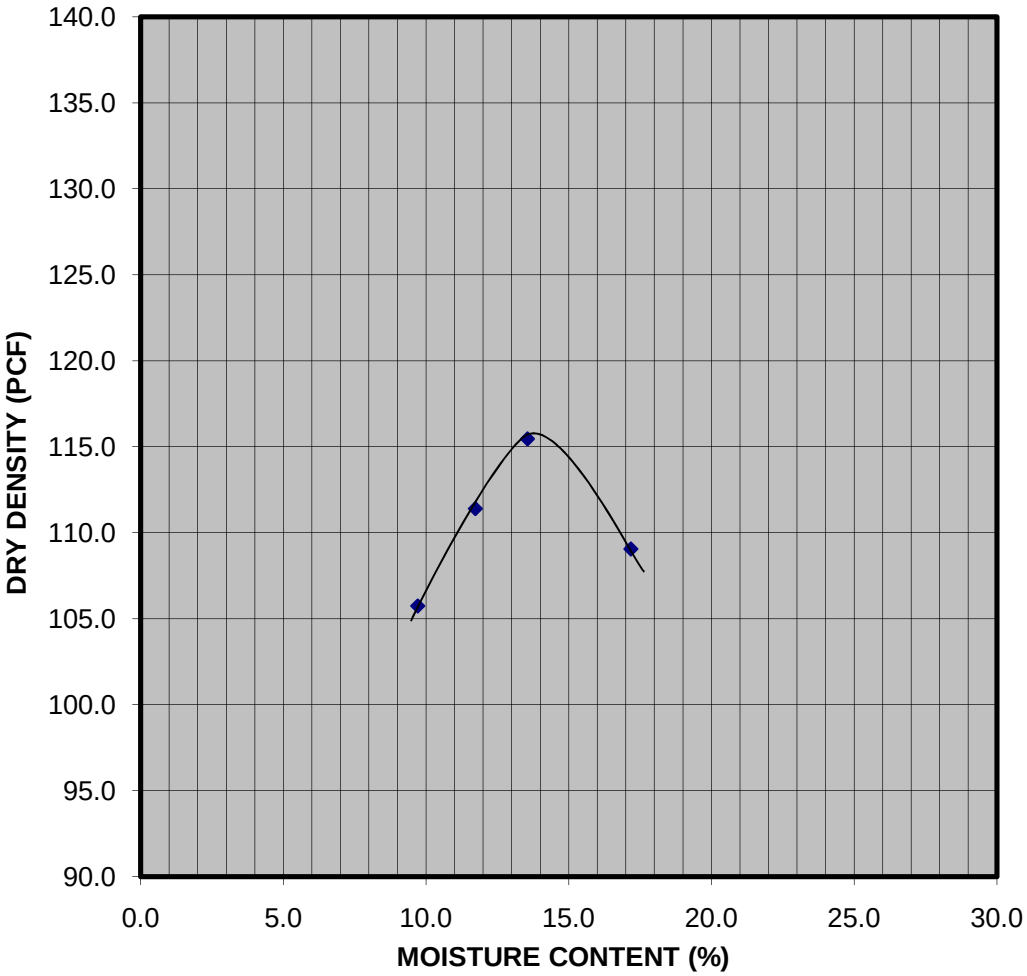


Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-3**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Dark Tan, Fine, with Clay
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 115.8
Optimum Moisture (%): 13.7



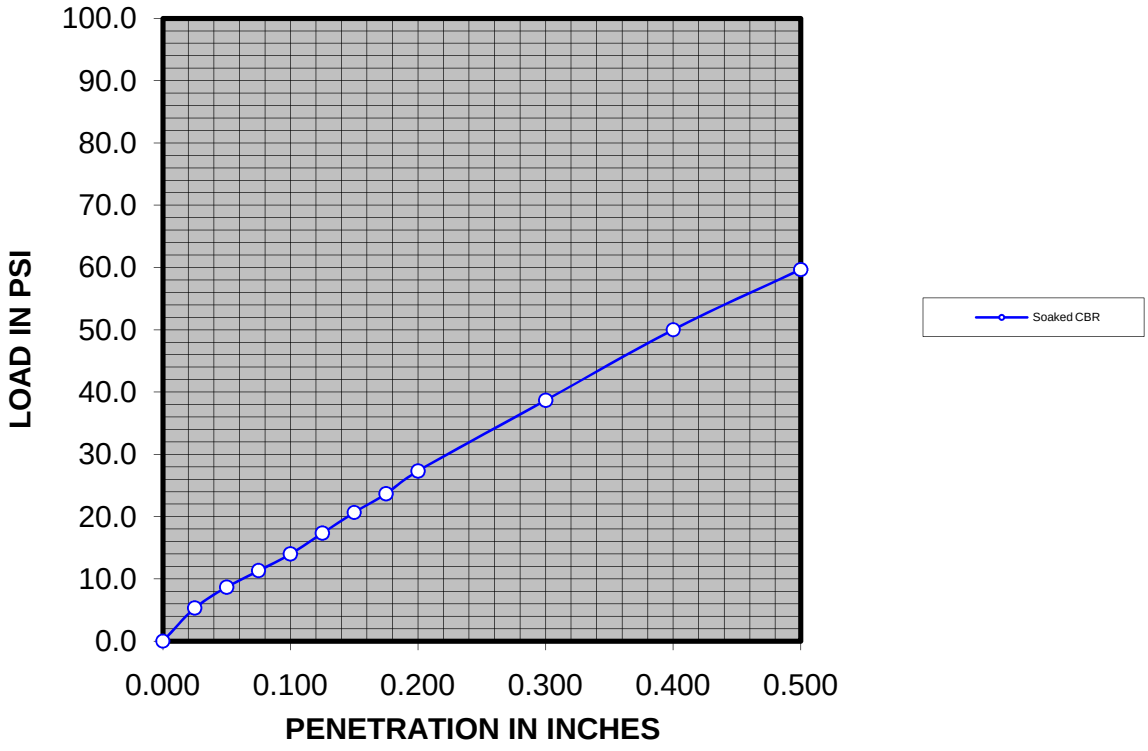
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-3**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Dark Tan, Fine, with Clay
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	115.8	Blows Per Layer:	35
Optimum Moisture (%):	13.7	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	94.6
After Soaking Moisture (%):	15.6	Compaction After Soaking (%):	94.4

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**1.4**
Swell (%):	**0.2**

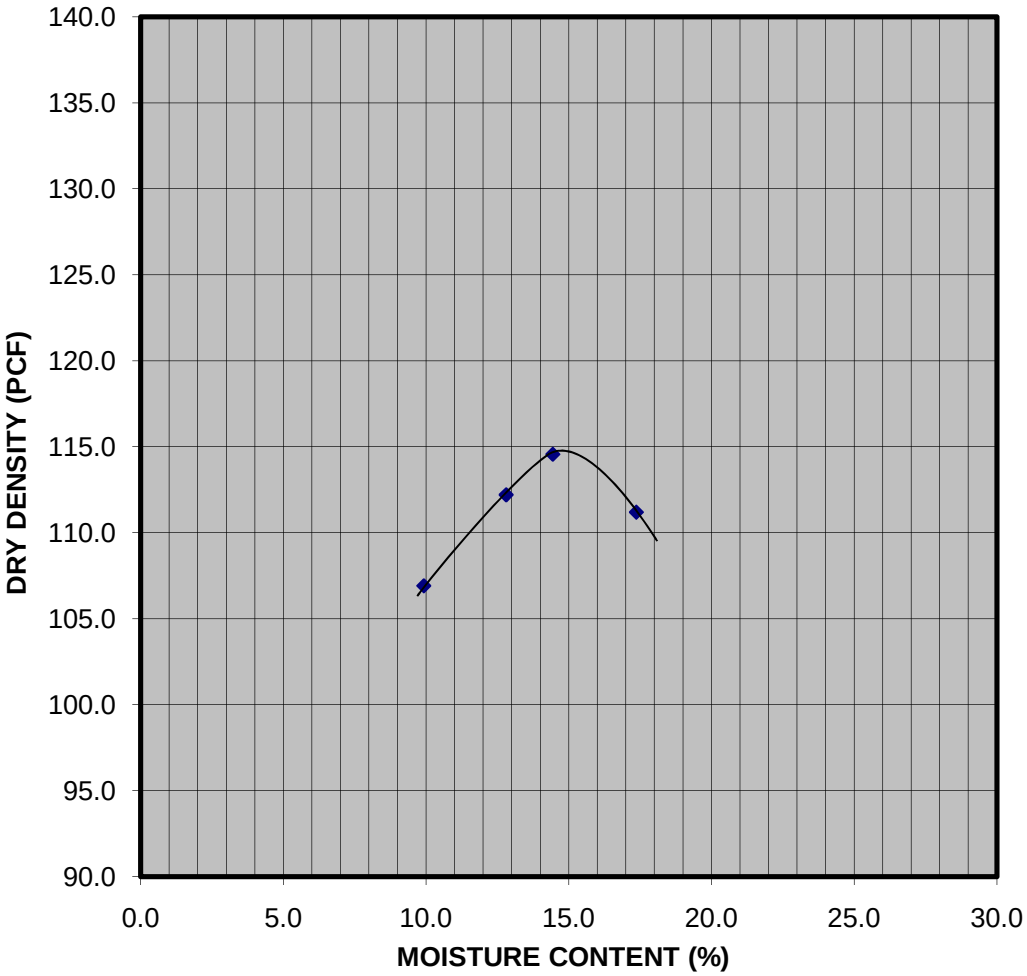


Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-8**
Sample Depth:	1 to 2 feet
Sample Description:	Sandy CLAY (CL), Tan-Orange, with Silt
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 114.8
Optimum Moisture (%): 14.7



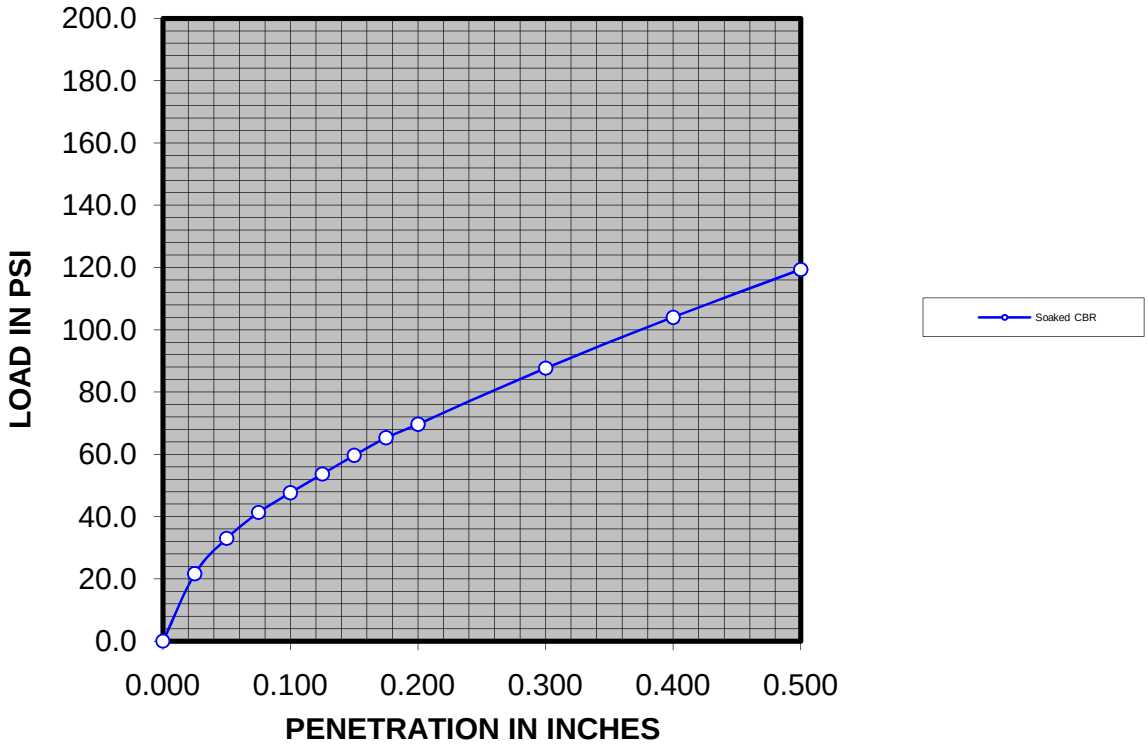
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-8**
Sample Depth:	1 to 2 feet
Sample Description:	Sandy CLAY (CL), Tan-Orange, with Silt
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	114.8	Blows Per Layer:	35
Optimum Moisture (%):	14.7	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	95.2
After Soaking Moisture (%):	16.8	Compaction After Soaking (%):	94.8

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**4.8**
Swell (%):	**0.4**

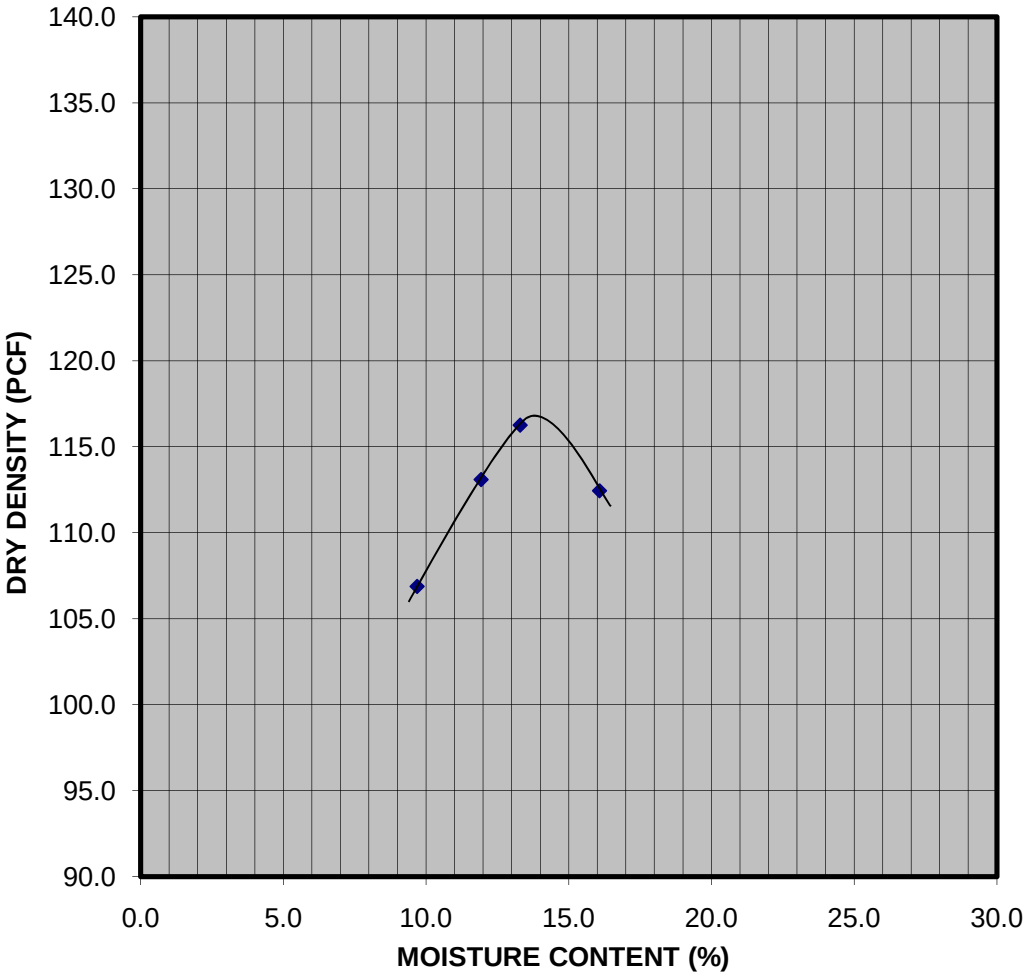


Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-9**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Tan, Fine, with Clay
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 116.8
Optimum Moisture (%): 13.7



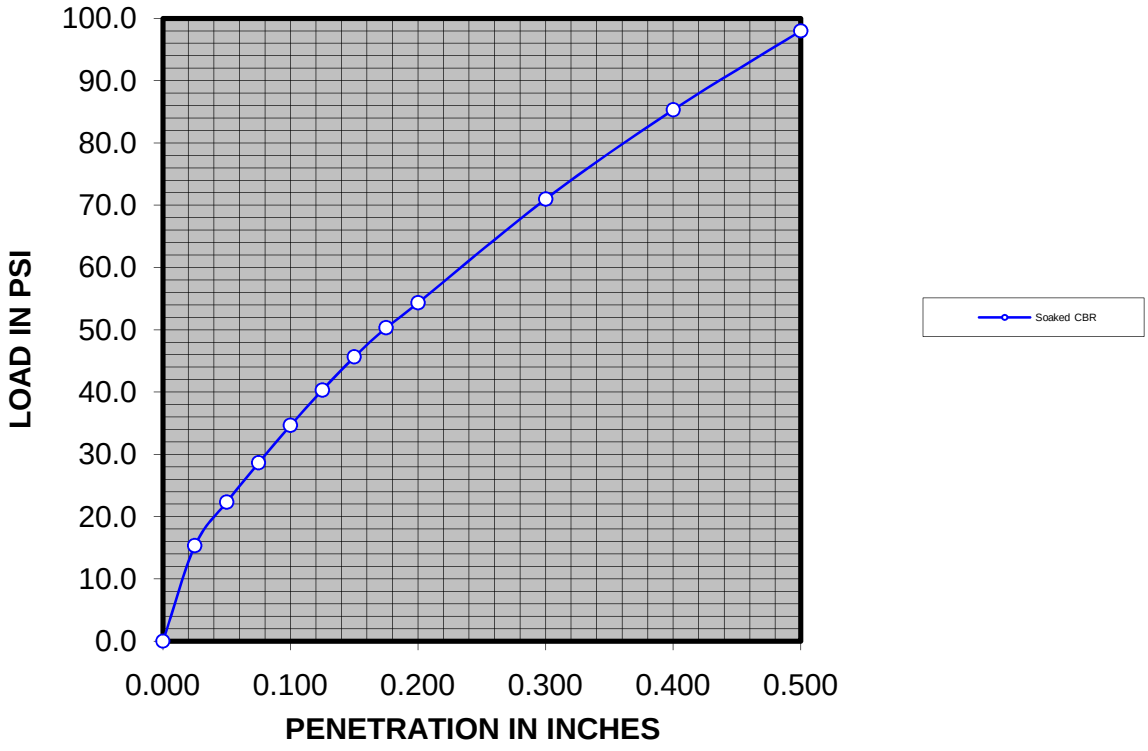
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-9**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Tan, Fine, with Clay
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	116.8	Blows Per Layer:	35
Optimum Moisture (%):	13.7	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	95.2
After Soaking Moisture (%):	16.6	Compaction After Soaking (%):	95.1

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**3.5**
Swell (%):	**0.1**

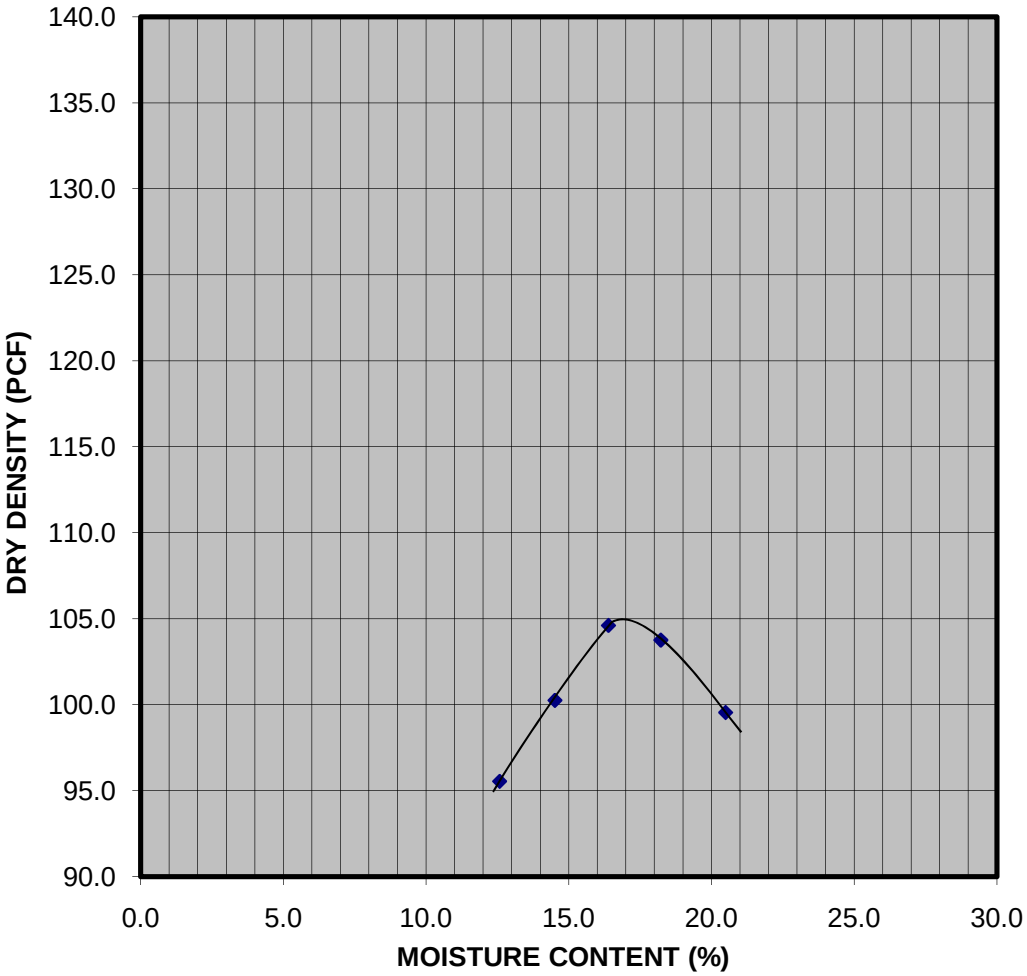


Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-13**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Brown, Fine, with Clay
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 105.0
Optimum Moisture (%): 16.7



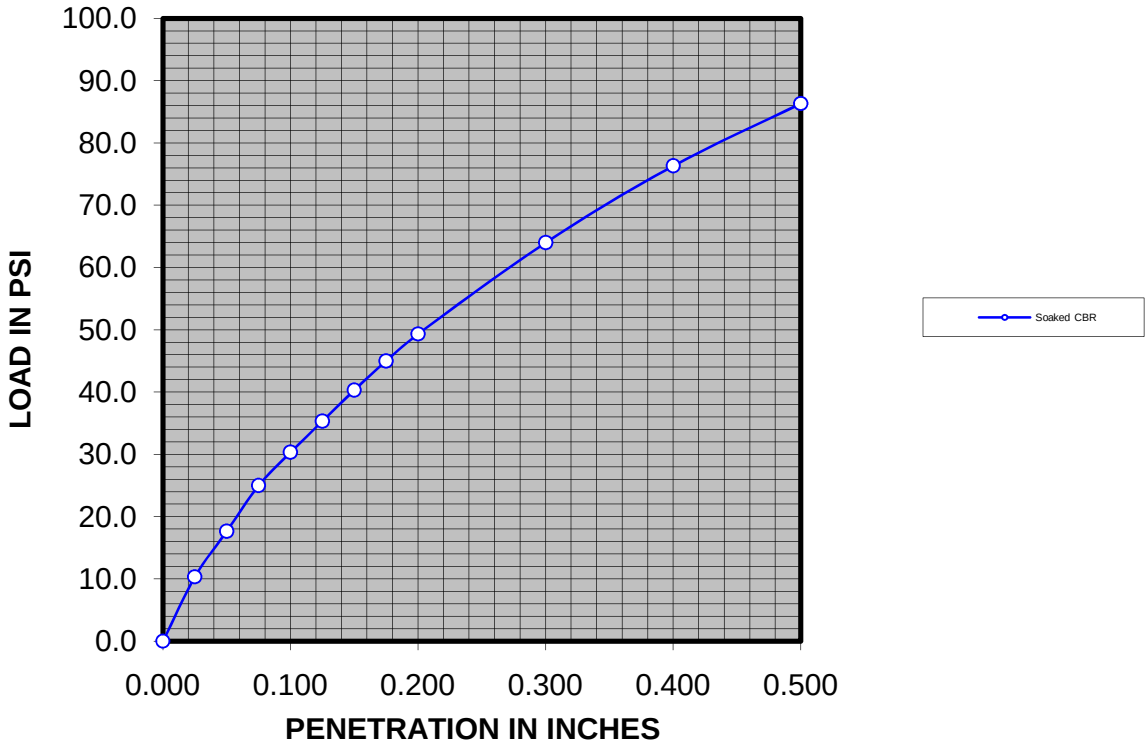
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-13**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Brown, Fine, with Clay
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	105.0	Blows Per Layer:	35
Optimum Moisture (%):	16.7	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	95.8
After Soaking Moisture (%):	18.8	Compaction After Soaking (%):	95.5

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**3.0**
Swell (%):	**0.3**

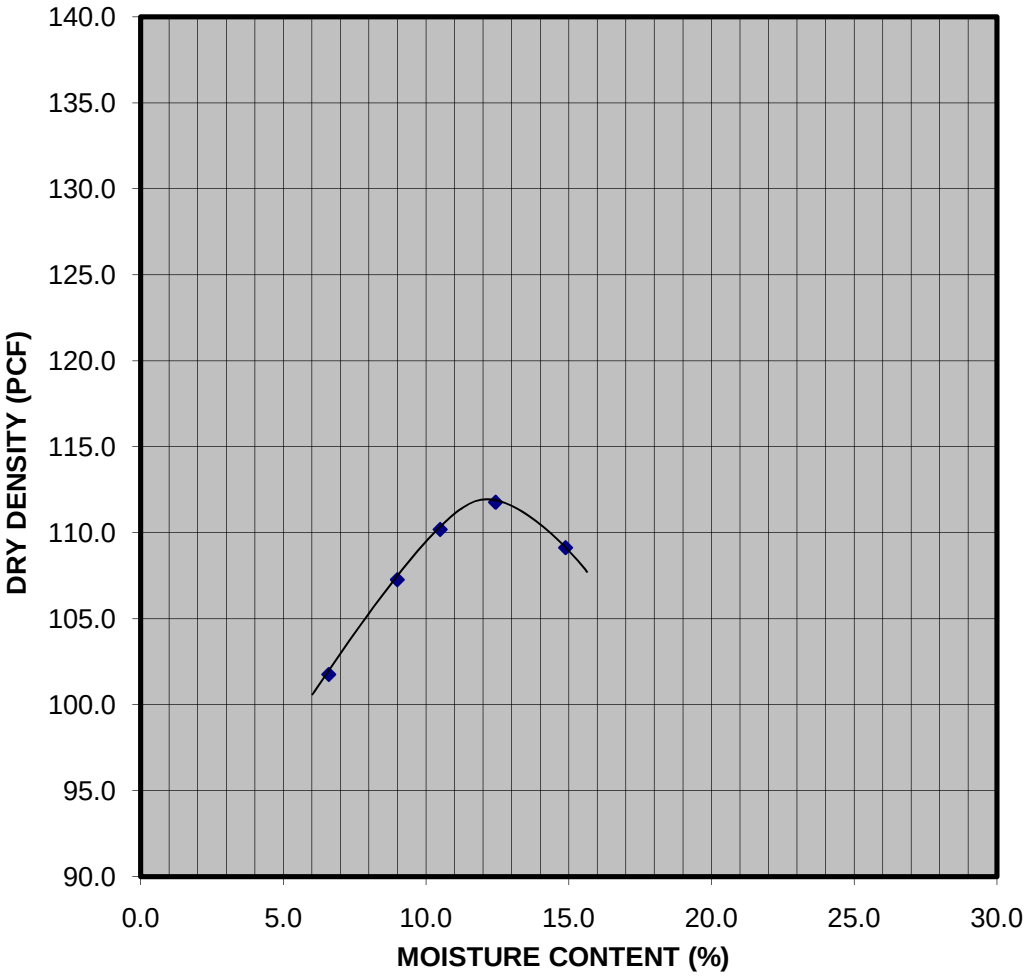


Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-14**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Dark Tan, Fine to Medium, Trace Clay
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 112.2
Optimum Moisture (%): 11.9



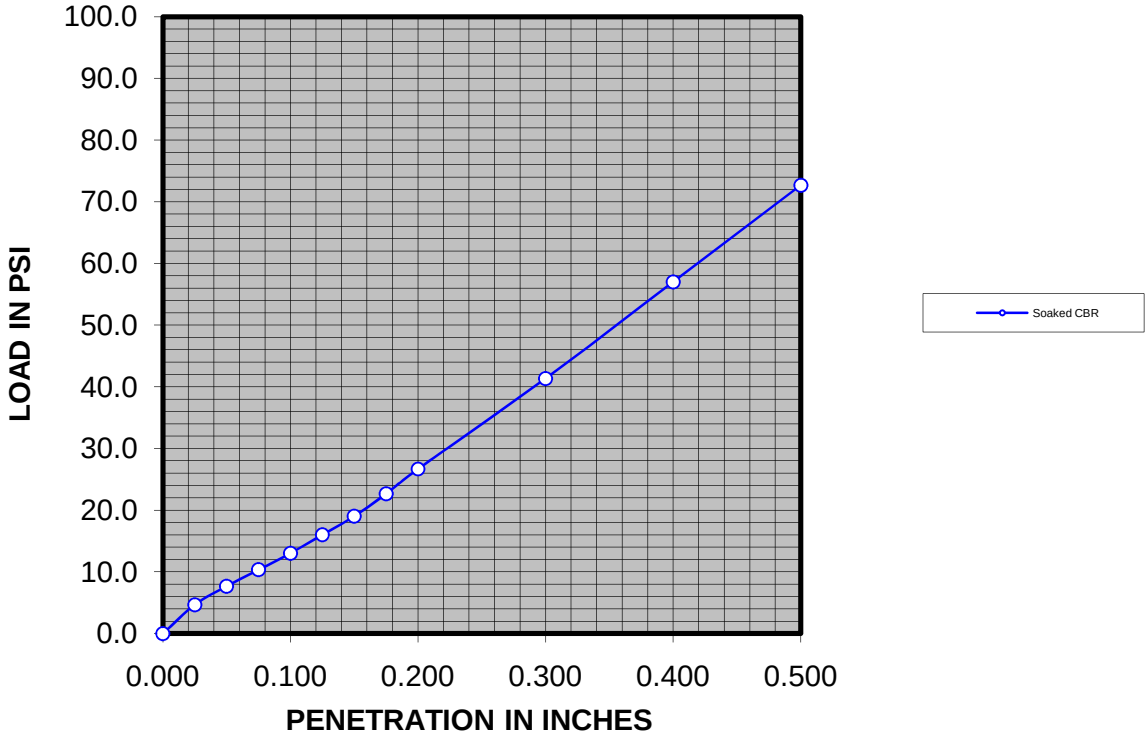
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-14**
Sample Depth:	1 to 2 feet
Sample Description:	Silty SAND (SM), Dark Tan, Fine to Medium, Trace Clay
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	112.2	Blows Per Layer:	35
Optimum Moisture (%):	11.9	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	95.5
After Soaking Moisture (%):	15.5	Compaction After Soaking (%):	95.4

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**2.0**
Swell (%):	**0.0**



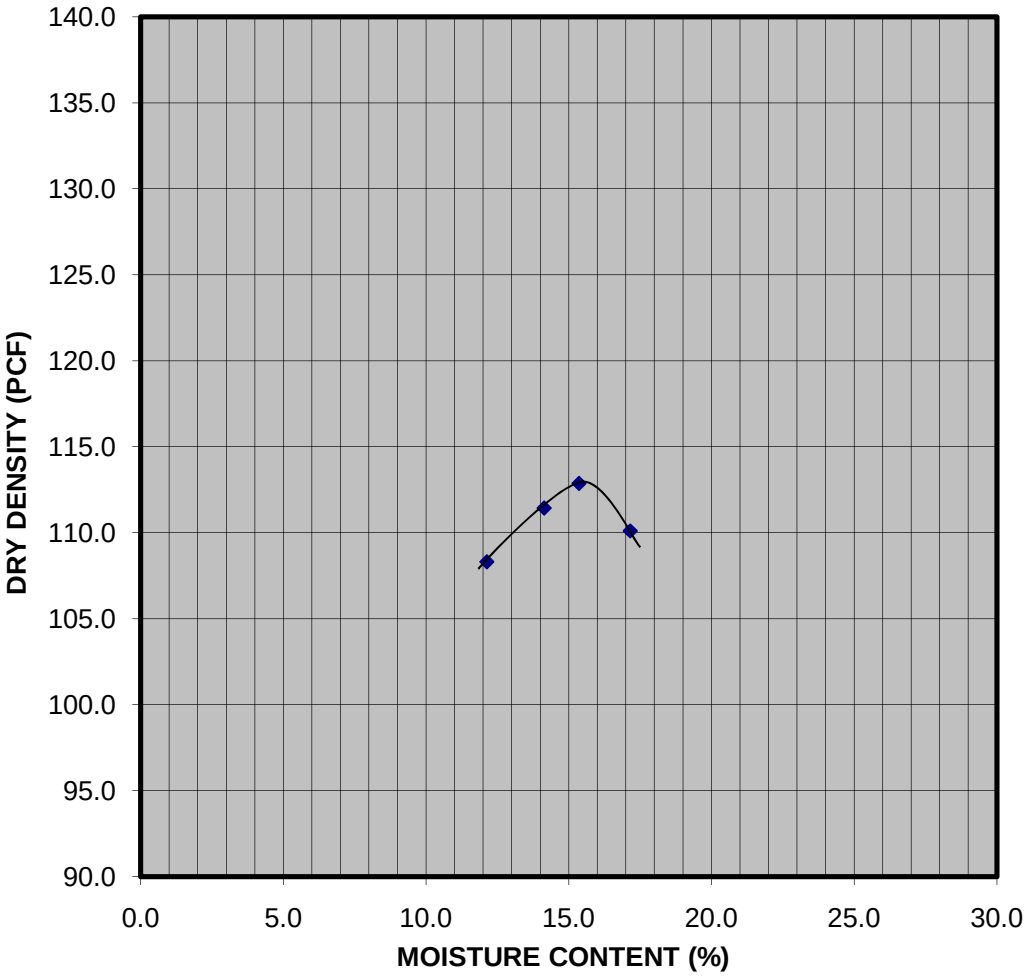
*CBR value corrected for concave upward shape

Engineering and Testing Consultants, Inc.

MOISTURE-DENSITY RELATIONSHIP

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-18**
Sample Depth:	1 to 2 feet
Sample Description:	Sandy CLAY (CL), Tan-Orange, with Silt
Test Method:	ASTM D 698A

Maximum Dry Density (pcf): 113.0
Optimum Moisture (%): 15.5



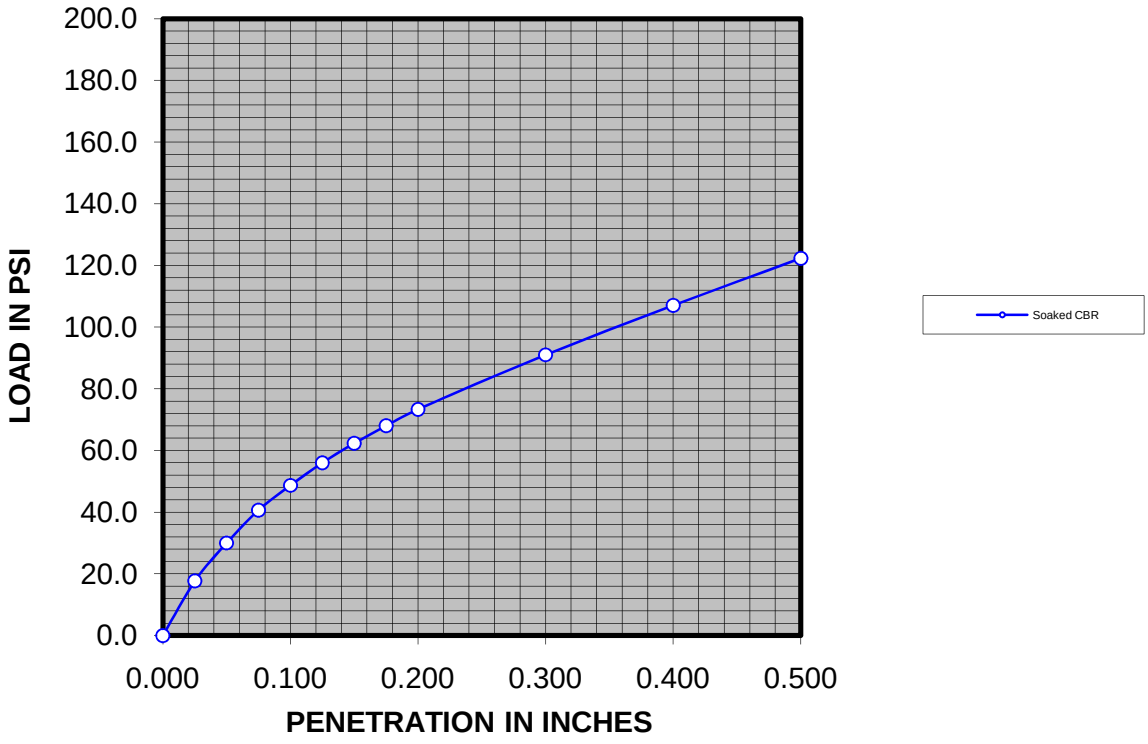
Engineering and Testing Consultants, Inc.

CALIFORNIA BEARING RATIO TEST

Project Name:	**P984-P989 MCSFRC Phase 1 NWS Yorktown**
GER Project Number:	**110-5960**
Number:	5336-110
Sample Number:	**P-18**
Sample Depth:	1 to 2 feet
Sample Description:	Sandy CLAY (CL), Tan-Orange, with Silt
Test Method:	ASTM D 1883

Maximum Dry Density (pcf):	113.0	Blows Per Layer:	35
Optimum Moisture (%):	15.5	Surcharge Weight (lbs.):	15
In Situ Moisture (%):	N/S	Compaction Before Soaking (%):	93.2
After Soaking Moisture (%):	18.5	Compaction After Soaking (%):	92.9

Unsoaked CBR Value:	**N/A**
Soaked CBR Value:	**4.9**
Swell (%):	**0.4**



APPENDIX D

PROCEDURES AND INTERPRETATION METHODS

GEOTECHNICAL EXPLORATION PROCEDURES

Boring, Sampling & Standard Penetration Testing

Standard penetration testing and split barrel sampling are conducted at regular intervals in a borehole in accordance with ASTM D 1586. Standard practice on most GER projects is to perform this testing and sampling continuously within the upper 10 feet of the subsurface, and then at maximum 5-foot center-to-center intervals thereafter. At the desired test depth, the drilling tools are removed and a split barrel sampler is connected to the drilling rods and lowered back into the borehole. The sampler is first seated six inches into the bottom of the hole to penetrate any loose cuttings from the drilling operations. It is then driven an additional 12 inches by the impact of a 140 pound hammer free-falling 30 inches. The number of hammer blows required to drive the sampler for each 6-inch interval is recorded. The combined number of blows required to drive the sampler the final 12 inches is designated *standard penetration resistance* or *N-value*. Representative portions of soil from each split barrel sample are placed in air tight glass jars or plastic bags and transported to a laboratory.

Undisturbed Sampling

Split barrel samples are used for visual examination and simple laboratory classification tests; however, they are disturbed and not sufficiently intact for quantitative laboratory testing such as strength or consolidation. When such laboratory testing is desired, relatively undisturbed samples are obtained by slowly pushing a 3-inch diameter, thin-walled (16 gauge) galvanized steel tube into the soil at desired sampling depths. This is followed by carefully removing the soil-filled tube from the borehole and sealing the ends to prevent moisture loss. The procedure is described in ASTM D 1587. Undisturbed tube samples are most frequently used for sampling cohesive soils (clay and silt), but may be used to sample fine grained cohesionless soils with the aid of a piston sampling head.

Excavation

When explorations do not require machine-drilled borings, excavations, test pits, hand auger borings and other means described in ASTM D 4700 may be used to observe shallow subsurface conditions and to collect soil samples. The maximum depth of these methods is generally limited by the depth of groundwater. These methods are useful in obtaining bulk samples for laboratory classification, compaction and other remolded tests.

Rock Coring

Core drilling methods described in ASTM D 2113 are used to advance boreholes into rock or extremely dense soils which are not penetrable by conventional boring methods and typically exhibit more than 100 blows per foot by ASTM D 1586. Core drilling methods employed by GER use double tube swivel-type designed equipment with a drilling fluid, in which an outer tube rotates and performs the cutting while the inner tube remains stationary and collects a continuous sample of rock.

In-Situ Methods

In-situ tests are sometimes used on projects to obtain additional subsurface data. These methods provide direct and empirical measurement of various soil properties without collection of actual samples. Because samples are not collected, it is not common practice in the U. S. to

utilize in-situ tests alone to accomplish geotechnical investigations. On projects where in-situ testing is used, it is customary to perform them in conjunction with borings.

Soil Classification

Soil classification tests provide a general guide to the engineering properties of various soil types. Samples obtained during drilling operations are examined and visually classified by an engineer or geologist according to consistency, color and texture. These classification descriptions are included on the boring records. The classification system is primarily qualitative and for detailed soil classification, two laboratory tests are necessary; grain size tests and plasticity tests. Using these test results, the soil can be classified according to the AASHTO or Unified Classification System (ASTM D 2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented on the following sheets.

Grain Size Tests

Grain size tests are performed to determine the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D 421 (dry preparation) or ASTM D 2217 (wet preparation). The grain size distribution of soils coarser than the #200 U.S. Standard Sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Materials passing the No. 200 sieve are suspended in water and the grain size distribution calculated from the measured settlement rate. These tests are conducted in accordance with ASTM D 422.

Plasticity Tests

Plasticity tests are performed to determine the soil classification and plasticity characteristics. The soil plasticity characteristics are defined by the Plastic Index (PI) and the Liquid Limit (LL). The PI is related to the volume changes which occur in confined soils beneath foundations. The PI and LL are determined in accordance with ASTM D 4318.

Physical Properties

The in-place physical properties are described by the specific gravity, wet unit weight, moisture content, dry unit weight, void ratio and percent saturation of the soil. The specific gravity and moisture content are determined by ASTM D 854 and D 2216, respectively. The wet unit weight is found by obtaining a known volume of soil and dividing the wet sample weight by the known volume. The dry unit weight, void ratio and percent saturation are calculated values.

California Bearing Ratio

The California Bearing Ratio (CBR) test is a comparative measure of the shearing resistance of a soil. It is used with empirical curves to design asphalt pavement structures. The test is performed in accordance with ASTM D 1883 or Virginia Test Method Designation VTM-8. A representative bulk sample is compacted in a six-inch diameter CBR mold in five (5) equal layers, using 45 evenly spaced blows per layer with a 5.5 lb. hammer falling 12 inches. CBR tests may be run on the compacted samples in either soaked or unsoaked conditions, with samples penetrated at the rate of .05 inches per minute to a depth of 0.5 inches. The CBR value is the percentage of the load it takes to penetrate the soil to a specified depth compared to the load it takes to penetrate a standard crushed stone to the same depth.

Consolidation Tests

Consolidation tests determine the change in height of a soil sample with increasing load. The results of these tests are used to estimate the settlement and time rate of settlement of structures constructed on similar soils. The test is run in accordance with ASTM D 2435 on a single element of an extruded undisturbed sample. The test sample is trimmed into a disk approximately 2½ inches in diameter and one inch thick. The disk is confined in a stainless steel ring and sandwiched between porous plates and subjected to incrementally increasing vertical loads, with the resulting deformations measured with micrometer dial gauges. Void ratios and percent strain deformation are then calculated from these readings. The test results are presented in the form of a stress-strain or vertical pressure versus void ratio curve.

Triaxial Shear Tests

Triaxial shear tests are used to determine the strength characteristics and elastic properties of a soil sample. Triaxial shear tests are conducted either on relatively undisturbed samples of virgin material or on remolded-compacted samples of representative site materials. The samples are then trimmed into cylinders and encased in rubber membranes. Each is then placed into a compression chamber and confined by hydrostatic cell pressure. An axial load is applied until the sample fails in shear. Test results are presented in the form of stress-strain curves and stress paths to failure.

Various types of triaxial tests may be performed. The most suitable type of triaxial test is determined by the loading conditions imposed on the soil in the field and by drainage characteristics of the site. Types of triaxial tests normally performed include:

- Consolidated-Isotropic-Undrained (CIU test)
- Consolidated-Anisotropic-Undrained (CK_oU test)
- Consolidated-Isotropic-Drained (CID test)
- Consolidated-Anisotropic-Drained (CK_oD test)
- Unconsolidated-Undrained (UU test)

GeoEnvironmental Resources, Inc.

Dilatometer (DMT) Data Reduction Correlations

Corrected First Reading	$p_0 = 1.05(A - Z_M + \Delta A) - 0.05(B - Z_M - \Delta B)$	
Corrected Second Reading	$p_1 = B - Z_M - \Delta B$	
Corrected Third Reading	$p_2 = C - Z_M + \Delta A$	
Material Index	$I_D = \frac{p_1 - p_o}{p_o - u_o}$	Marchetti, 1997
Horizontal Stress Index	$K_D = \frac{p_o - u_o}{\sigma'_{vo}}$	
Dilatometer Modulus	$E_D = 34.7(p_1 - p_o)$	
Coeff. Earth Pressure In Situ	$K_o = \left(\frac{K_D}{1.5}\right)^{0.47} - 0.6$	
Overconsolidation Ratio	$OCR = (0.5K_D)^{1.56}$	
Undrained Shear Strength	$c_u = 0.22\sigma'_{vo}(0.5K_D)^{1.25}$	
Friction Angle	$\phi = 28 + 14.6\log K_D - 2.1\log^2 K_D$	
Vertical Drained Constrained Modulus	$M_{DMT} = R_M E_D$ If $I_D \le 0.6$ $R_M = 0.14 + 2.36\log K_D$ If $I_D \ge 3$ $R_M = 0.5 + 2\log K_D$ If $0.6 < I_D < 3$ $R_M = R_{M,o} + (2.5 - R_{M,o})\log K_D$ where $R_{M,o} = 0.14 + 0.15(I_D - 0.6)$ If $K_D > 10$ $R_M = 0.32 + 2.18\log K_D$ If $R_M < 0.85$ set $R_M = 0.85$	
Friction Angle	$\phi' = 37.3\left[\frac{K_D - 0.8}{K_o + 0.8}\right]^{0.082}$	Campanella & Robertson, 1991
Preconsol. Stress	$\sigma_p' = 0.509\ (p_o - u_o)$	Mayne, 1995
Total Unit Weight	$\gamma_T = 1.12\gamma_w \left(\frac{E_D}{p_a}\right)^{0.1} I_D^{-0.05}$	Mayne, et. al., 2002
Undrained Shear Strength	$s_u = \frac{p_o - u_o}{10}$	Schmertmann, 1981

Definitions

ΔA Reading: Quantification of resistance imparted by membrane to travel from the membrane's natural position to the A-position.

ΔB Reading: Quantification of resistance imparted by membrane to travel from the membrane's natural position to the B-position

A Position: Membrane just above feeler on sensing disk. Approximately flush with blade.

B Position: Membrane extended 1.1 mm into surrounding soil.

A Reading: Inflation pressure (reported in bar) required to expand membrane to A-position

B Reading: Inflation pressure (reported in bar) required to expand membrane to B-position.

C Reading: Deflation pressure (reported in bar) recorded when membrane is slowly deflated and returns to A- position.

Z_M: Zero gage reading. Reading of pressure gage when system is vented to atmosphere.

References

Marchetti S. (1997). "The Flat Dilatometer: Design Applications". Third Geotechnical Engineering Conference, Cairo University. Keynote lecture, 26 pp, Jan. 1997.

Campanella, R.G., and Robertson, P.K. (1991). Use and interpretation of a research dilatometer. Canadian Geotechnical Journal, **28**: 113-126.

Mayne, P.W. (1995) CPT determinations of overconsolidation ratio and lateral stresses in clean quartz sands, *Proceedings*, International Symposium on Cone Penetration Testing (CPT '95), Vol. 2, Swedish Geotechnical Society Report No. 3:95, Linkoping, pp. 215-220.

Mayne, P.W., Christopher, B., Berg, R., and DeJong, J. (2002). *Subsurface Investigations - Geotechnical Site Characterization*. Publication No. FHWA-NHI-01-031, National Highway Institute, Federal Highway Administration, Washington, D.C., 301 pages.
Schmertmann, J.H. (1981). Discussion to Marchetti (1980). Journal of the Geotechnical Engineering Division, ASCE, Vol. 107, No. GT6: 831-832. June, 1981.

ConeTec Interpretations as of March 12, 2008

ConeTec's interpretation routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended. ConeTec does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the program and does not assume liability for any use of the results in any design or review. Representative hand calculations should be made for any parameter that is critical for design purposes. The end user of the interpreted output should also be fully aware of the techniques and the limitations of any method used in this program. The purpose of this document is to inform the user as to which methods were used and what the appropriate papers and/or publications are for further reference.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (e.g. 0.20m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. Since all ConeTec cones have equal end area friction sleeves, pore pressure corrections to sleeve friction, f_s, are not required.

The tip correction is: $q_t = q_c + (1-a) \bullet u_2$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the cone (typically 0.80 for ConeTec cones)

The total stress calculations are based on soil unit weights that have been assigned to the Soil Behavior Type zones, from a user defined unit weight profile or by using a single value throughout the profile. Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). For over water projects the effects of the column of water have been taken into account as has the appropriate unit weight of water. How this is done depends on where the instruments were zeroed (i.e. on deck or at mud line).

Details regarding the interpretation methods for all of the interpreted parameters are provided in Table 1. The appropriate references cited in Table 1 are listed in Table 2. Where methods are based on charts or techniques that are too complex to describe in this summary the user should refer to the cited material.

The estimated Soil Behavior Types (normalized and non-normalized) are based on the charts developed by Robertson and Campanella shown in Figures 1 and 2. The Bq classification charts are not reproduced in this document but can be reviewed in Lunne, Robertson and Powell (1997) or Robertson (1990).

Where the results of a calculation/interpretation are declared *'invalid'* the value will be represented by the text strings "-9999" or "-9999.0". In some cases the value 0 will be used. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g. drilled out section or data gap).

2. Where the interpretation method is inappropriate, for example, drained parameters in an undrained material (and vice versa).

3. Where interpretation input values are beyond the range of the referenced charts or specified limitations of the interpretation method.

4. Where pre-requisite or intermediate interpretation calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the interpreted parameters listed in Table 1 may be included in the output files delivered with this report.

The output files are provided in Microsoft Excel XLS format. The ConeTec software has several options for output depending on the number or types of interpreted parameters desired. Each output file will be named using the original COR file basename followed by a three or four letter indicator of the interpretation set selected (e.g. BSC, TBL, NLI or IFI) and possibly followed by an operator selected suffix identifying the characteristics of the particular interpretation run.

Table 1
CPT Interpretation Methods

Interpreted Parameter	Description	Equation	Ref
Depth	Mid Layer Depth *(where interpretations are done at each point then Mid Layer Depth = Recorded Depth)*	*Depth (Layer Top) + Depth (Layer Bottom) / 2.0*	
Elevation	Elevation of Mid Layer based on sounding collar elevation supplied by client	Elevation = Collar Elevation - Depth	
Avgqc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n}\sum_{i=1}^{n} q_c$ *n=1 when interpretations are done at each point*	
Avgqt	Averaged corrected tip (q_t) where: $q_t = q_c + (1-a) \bullet u$	$Avgqt = \frac{1}{n}\sum_{i=1}^{n} q_t$ *n=1 when interpretations are done at each point*	
Avgfs	Averaged sleeve friction (f_s)	$Avgfs = \frac{1}{n}\sum_{i=1}^{n} fs$ *n=1 when interpretations are done at each point*	
AvgRf	Averaged friction ratio (Rf) where friction ratio is defined as: $Rf = 100\% \bullet \frac{fs}{qt}$	$AvgRf = 100\% \bullet \frac{Avgfs}{Avgqt}$ *n=1 when interpretations are done at each point*	
Avgu	Averaged dynamic pore pressure *(u)*	$Avgu = \frac{1}{n}\sum_{i=1}^{n} u_i$ *n=1 when interpretations are done at each point*	
AvgRes	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} RESISTIVITY_i$ *n=1 when interpretations are done at each point*	
AvgUVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} UVIF_i$ *n=1 when interpretations are done at each point*	
AvgTemp	Averaged Temperature (this data is not always available since it is a specialized test)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} TEMPERATURE_i$ *n=1 when interpretations are done at each point*	
AvgGamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} GAMMA_i$ *n=1 when interpretations are done at each point*	
SBT	Soil Behavior Type as defined by Robertson and Campanella	See Figure 1	2, 5

Interpreted Parameter	Description	Equation	Ref
U.Wt.	Unit Weight of soil determined from one of the following user selectable options: 1) uniform value 2) value assigned to each SBT zone 3) user supplied unit weight profile	See references	5
T. Stress σ_v	Total vertical overburden stress at Mid Layer Depth. *A layer is defined as the averaging interval specified by the user. For data interpreted at each point the Mid Layer Depth is the same as the recorded depth.*	$TStress = \sum_{i=1}^{n} \gamma_i h_i$ *where* γ_i is layer unit weight h_i is layer thickness	
E. Stress σ_v'	Effective vertical overburden stress at Mid Layer Depth	*Estress = Tstress -* u_{eq}	
Ueq	Equilibrium pore pressure determined from one of the following user selectable options: 1) hydrostatic from water table depth 2) user supplied profile	For hydrostatic option: $u_{eq} = \gamma_w \bullet (D - D_{wt})$ where u_{eq} is equilibrium pore pressure γ_w is unit weight of water D is the current depth D_{wt} is the depth to the water table	
Cn	SPT N_{60} overburden correction factor	$Cn=(\sigma_v')^{-0.5}$ where σ_v' *is in tsf* $0.5 < C_n < 2.0$	
N_{60}	SPT N value at 60% energy calculated from qt/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	*See Figure 1*	4, 5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure	$(N_1)_{60} = Cn \bullet N_{60}$	4
$N_{60}I_c$	SPT N_{60} values based on the Ic parameter	(qt/pa)/ N_{60} = 8.5 (1 – Ic/4.6)	5
$(N_1)_{60}Ic$	SPT N_{60} value corrected for overburden pressure (using N_{60} I_c). User has 2 options.	1) $(N_1)_{60}Ic = Cn \bullet (N_{60}\, Ic)$ 2) $q_{c1n}/ (N_1)_{60}Ic$ = 8.5 (1 – Ic/4.6)	4 5
$(N_1)_{60cs}Ic$	Clean sand equivalent SPT $(N_1)_{60}Ic$. User has 3 options.	1) $(N_1)_{60cs}Ic = \alpha + \beta((N_1)_{60}Ic)$ 2) $(N_1)_{60cs}Ic = K_{SPT} * ((N_1)_{60}Ic)$ 3) $q_{c1ncs}/ (N_1)_{60cs}Ic$ = 8.5 (1 – Ic/4.6) FC ≤ 5%: α = 0, β=1.0 FC ≥ 35% α = 5.0, β=1.2 5% < FC < 35% $\alpha = \exp[1.76 - (190/FC^2)]$ $\beta = [0.99 + (FC^{1.5}/1000)]$	10 10 5
Su	Undrained shear strength - N_{kt} is user selectable	$Su = \frac{qt - \sigma_v}{N_{kt}}$	1, 5
k	Coefficient of permeability (assigned to each SBT zone)		5
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{qt - \sigma_v}$ *where:* $\Delta u = u - u_{eq}$ *and u = dynamic pore pressure* u_{eq} *= equilibrium pore pressure*	1, 5
Q_t	Normalized q_t for Soil Behavior Type classification as defined by Robertson, 1990	$Qt = \frac{qt - \sigma_v}{\sigma_v'}$	2, 5

Interpreted Parameter	Description	Equation	Ref
F_r	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson, 1990	$Fr = 100\% \bullet \frac{fs}{qt - \sigma_v}$	2, 5
SBTn	Normalized Soil Behavior Type as defined by Robertson and Campanella	See Figure 2	2, 5
SBT-BQ	Non-normalized soil behavior type based on the Bq parameter	See Figure 5.7 (reference 5)	2, 5
SBT-BQn	Normalized Soil Behavior base on the Bq parameter	See Figure 5.8 (reference 5) or Figure 3 (reference 2)	2, 5
I_c	Soil index for estimating grain characteristics	$Ic = [(3.47 - \log_{10}Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$ *Where:* $Q = \left(\frac{qt - \sigma_v}{P_{a2}}\right)\left(\frac{P_a}{\sigma_v'}\right)^n$ *And* *Fr is in percent* *P_a = atmospheric pressure* *P_{a2} = atmospheric pressure* *n varies from 0.5 to 1.0 and is selected in an iterative manner based on the resulting I_c*	3, 8
FC	Apparent fines content (%)	*$FC=1.75(Ic^{3.25}) - 3.7$* *FC=100 for Ic > 3.5* *FC=0 for Ic < 1.26* *FC = 5% if 1.64 < Ic < 2.6 AND F_r<0.5*	3
Ic Zone	This parameter is the Soil Behavior Type zone based on the Ic parameter (valid for zones 2 through 7 on SBTn chart)	Ic < 1.31 Zone = 7 1.31 < Ic < 2.05 Zone = 6 2.05 < Ic < 2.60 Zone = 5 2.60 < Ic < 2.95 Zone = 4 2.95 < Ic < 3.60 Zone = 3 Ic > 3.60 Zone = 2	3
PHI ϕ	Friction Angle determined from one of the following user selectable options: a) Campanella and Robertson b) Durgunoglu and Mitchel c) Janbu d) Kulhawy and Mayne	See reference	5 5 5 11
Dr	Relative Density determined from one of the following user selectable options: a) Ticino Sand b) Hokksund Sand c) Schmertmann 1976 d) Jamiolkowski - All Sands	See reference	5
OCR	Over Consolidation Ratio	a) Based on Schmertmann's method involving a plot of S_u/σ_v' /($S_u/\sigma_v')_{NC}$ and OCR where the Su/p' ratio for NC clay is user selectable	9
State Parameter	The state parameter is used to describe whether a soil is contractive (SP is positive) or dilative (SP is negative) at large strains based on the work by Been and Jefferies	See reference	8, 6, 5
Es/qt	Intermediate parameter for calculating Young's Modulus, E, in sands. It is the Y axis of the reference chart.	Based on Figure 5.59 in the reference	5

Interpreted Parameter	Description	Equation	Ref
Young's Modulus E	Young's Modulus based on the work done in Italy. There are three types of sands considered in this technique. The user selects the appropriate type for the site from: a) OC Sands b) Aged NC Sands c) Recent NC Sands Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in the Es/qt chart.	Mean normal stress is evaluated from: $\sigma'_m = \frac{1}{3} \bullet \left(\sigma'_v + \sigma'_h + \sigma'_h\right)^3$ where σ_v'= vertical effective stress σ_h'= horizontal effective stress and $\sigma_h = K_o * \sigma_v'$ with Ko assumed to be 0.5	5
q_{c1}	q_t normalized for overburden stress used for seismic analysis	$q_{c1} = q_t \bullet (Pa/\sigma_v')^{0.5}$ where: Pa = atm. Pressure q_t is in Mpa	3
q_{c1n}	q_{c1} in dimensionless form used for seismic analysis	$q_{c1n} = (q_{c1} / Pa)(Pa/\sigma_v')$ where: Pa = atm. Pressure and n ranges from 0.5 to 0.75 based on Ic.	3
K_{SPT}	Equivalent clean sand factor for $(N_1)60$	$K_{SPT} = 1 + ((0.75/30) * (FC - 5))$	10
K_{CPT}	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $I_c \leq 1.64$ $K_{cpt} = f(I_c)$ for $I_c > 1.64$ (see reference)	10
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \bullet K_{cpt}$	3
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833\ [(q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93\ [(q_{c1ncs}/1000]^3 + 0.08$	10
CSR	Cyclic Stress Ratio	$CSR = (\tau_{av}/\sigma_v') = 0.65\ (a_{max} / g)\ (\sigma_v/ \sigma_v')\ r_d$ $r_d = 1.0 - 0.00765\ z$ $z \leq 9.15$m $r_d = 1.174 - 0.0267\ z$ $9.15 < z \leq 23$m $r_d = 0.744 - 0.008\ z$ $23 < z \leq 30$m $r_d = 0.50$ $z > 30$m	10
MSF	Magnitude Scaling Factor	See Reference	10
FofS	Factor of Safety against Liquefaction	$FS = (CRR_{7.5} / CSR)\ MSF$	10
Liquefaction Status	Statement indicating possible liquefaction	Takes into account FofS and limitations based I_c and q_{c1ncs}.	10

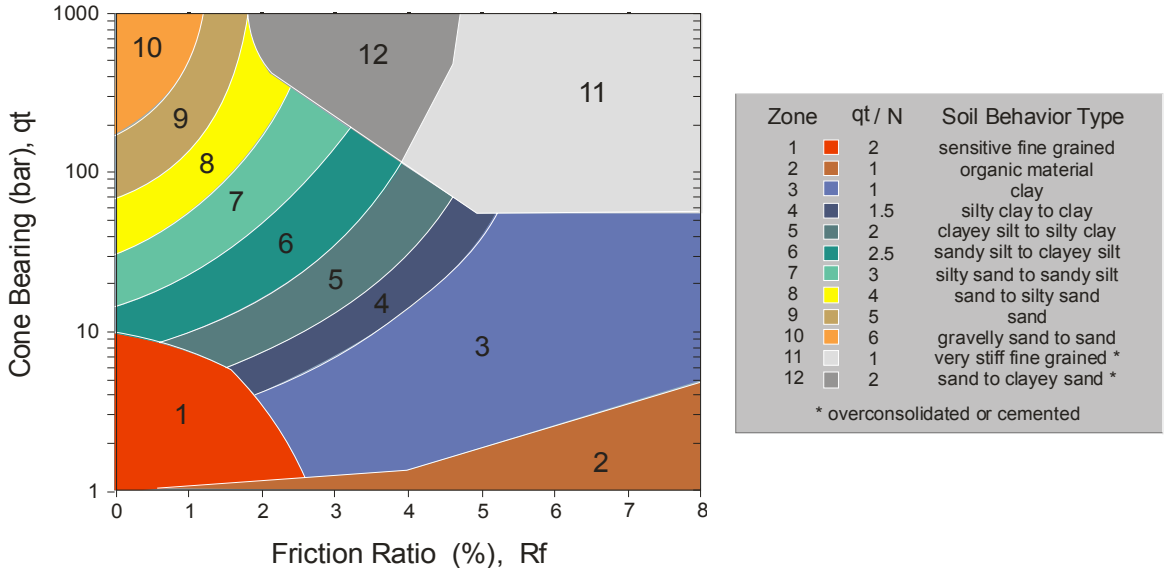


Figure 1 Non-Normalized Behavior Type Classification Chart

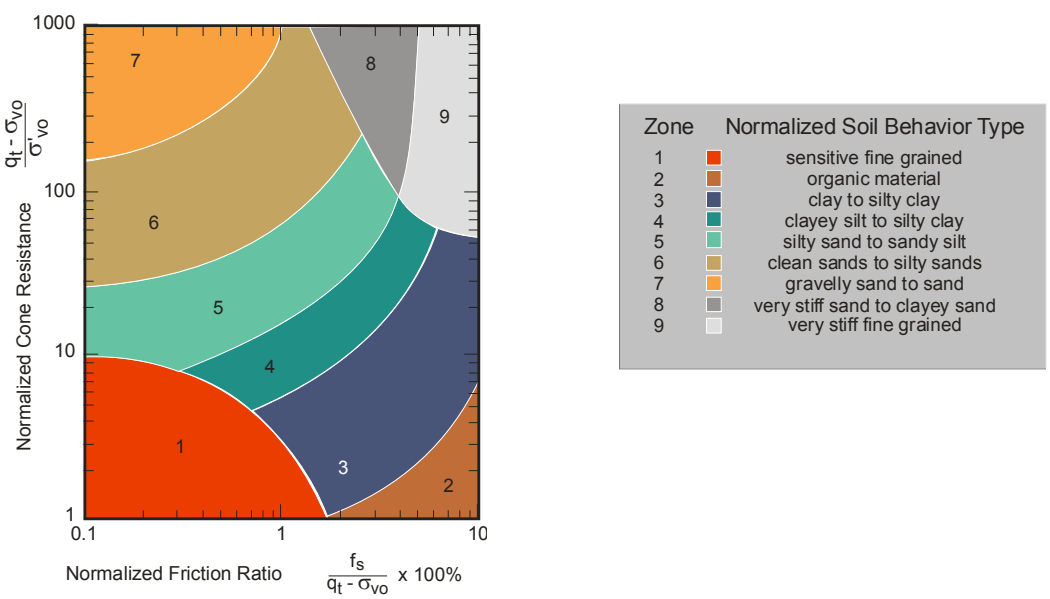


Figure 2 Normalized Behavior Type Classification Chart

Table 2 References

No.	References
1	Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.
2	Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27.
3	Robertson, P.K. and Fear, C.E., 1998, "Evaluating cyclic liquefaction potential using the cone penetration test", Canadian Geotechnical Journal, 35: 442-459.
4	Robertson, P.K. and Wride, C.E., 1998, "Cyclic Liquefaction and its Evaluation Based on SPT and CPT", NCEER Workshop Paper, January 22, 1997
5	Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, " Cone Penetration Testing in Geotechnical Practice," Blackie Academic and Professional.
6	Plewes, H.D., Davies, M.P. and Jefferies, M.G., 1992, "CPT Based Screening Procedure for Evaluating Liquefaction Susceptibility", 45th Canadian Geotechnical Conference, Toronto, Ontario, October 1992.
7	Jefferies, M.G. and Davies, M.P., 1993. "Use of CPTu to Estimate equivalent N_{60}", Geotechnical Testing Journal, 16(4): 458-467.
8	Been, K. and Jefferies, M.P., 1985, "A state parameter for sands", Geotechnique, 35(2), 99-112.
9	Schmertmann, 1977, "Guidelines for Cone Penetration Test Performance and Design", Federal Highway Administration Report FHWA-TS-78-209, U.S. Department of Transportation
10	Proceedings of theNCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Salt LakeCity, 1996. Chaired by Leslie Youd. 11
11	Kulhawy, F.H. and Mayne, P.W. ,1990, Manual on Estimating Soil Properties for Foundation Design, *Report No. EL-6800*, Electric Power Research Institute, Palo Alto, CA, August 1990, 306 p.